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Ewing's Theory of Magnetism. A VERY clever paper from the laboratory of Haverford College is published in our present issue. It gives an account of experiments made on an artificial magnet constructed to illustrate Prof. Ewing's beautiful theory of magnetization. The model was arranged in three dimensions, and consisted of a loosely wound coil composed of a single layer of wire with the turns nearly half an inch apart. Into this magnetizing coil were slid on proper supports a number of small magnets pivoted and balanced as in Prof. Ewing's experiments. The magnetic properties of this structure were then investigated with a magnetometer in the usual manner. One of the interesting results obtained was a sort of experimental demonstration of hysteresis, with the advantage of being able to watch the mutual action of the magnetic particles that may be supposed to produce it. The curves accompanying the paper give an excellent idea of the sort of interaction that may produce the phenomena that we know as hysteresis. In fact, the Ewing curves of soft iron and steel were fairly well duplicated with the model, and the conditions of instability at certain points in the magnetic cycle were well shown. Altogether, the research is one that deserves being followed up on a larger scale with more elaborate apparatus. One should not, however, attempt to draw too close an analogy between the mechanical behavior of such a model and the molecular relations found in actual magnets. The distance between the magnetic molecules may be the same, for example, in iron and steel, and the difference, which in the model is produced by differing distances, may in the real magnets be due to any one of a considerable number of causes.

The Short Gearless Motor. WE take pleasure in giving on another page the working drawings of a slow-speed, directly connected motor with which the Short Electric Railway Company has been carrying on experiments for some time past. As yet no roads on this system are in operation, but the new machine has seen some very hard experimental service and has acquitted itself well. The cuts that we published some weeks ago gave no exact details of its construction, but the present ones will enable our readers at a glance to see the methods that have been followed in solving what at first appeared to be a very difficult problem. The appearance of gearless motors such as this is encouraging. For the past two years we have steadily preached low-speed multipolar motors for electric traction, single-reduction gear at all hazards, gearless if possible. It is a great satisfaction now to see these principles reduced to practice in a commercial form, and there is every reason to expect that a year or two will see a large number of such machines in active operation. Already the Short company has taken several contracts for equipping roads, and by early summer several will doubtless be in running order, and will enable us to form a clearer idea as to the real merits of the type than any description can possibly give. There is no reason, however, to expect the development of any undesirable qualities incident to the gearless construction, for the results obtained with direct-connected motors on the City & South London Railway have been sufficiently encouraging to quiet the grave apprehensions that some electricians have felt regarding the effects of vibration on the armature. Not only will the gearless motor be a distinct advantage on account of its great commercial efficiency compared with the twice-geared motors, but it will be received with the utmost favor by a public that has become tired of the whirring and clattering that afflict most electric cars that have been in operation for any length of time.

The Diffusion of Ignorance. THE Brooklyn city fathers seem to be perturbed in spirit at the prospect of electric traction in their realm. They appear to have an almost superstitious fear of the trolley wire, a terror that is little allayed by the frantic objurgations hurled upon the system through the daily press, and the gloomy predictions of those who know nothing whatever about the matter except from the lurid descriptions of impossible accidents that exist only in reporters' imaginations. It is, of course, a well-known fact that, while one may go upon the housetop and bawl out the truth twenty-four hours in the day, little attention will be paid to it; while, if in the privacy of his chamber, he crawls into his closet and whispers a lie into his shoe, it will promptly find its way to the uttermost parts of the earth. Thus it is that no amount of iteration of the undisputed and incontestable fact that no fatal shock has ever been received by any human being from a trolley wire, fails to produce the slightest effect in calming the fears of the general public, while the bold assertion that the entrance of these deadly overhead wires into our streets means "imperiling the life of every citizen" is eagerly believed by a large proportion of the populace. What real satisfaction there is in imagining untold horrors surrounding an inoffensive trolley wire it is hard to tell. At the present time the number of persons who have received shocks from these aforesaid overhead wires is well up into the thousands, and yet no results more serious than a thorough scare and a few superficial burns have been recorded. In the face of all this, opposition to the overhead wires continues unabated, and, in fact, is growing in activity. Of course everybody is willing to admit that if a thoroughly reliable and practicable method of electric traction by some other system were devised it would be highly desirable for city use, but until the outlook for such is something more substantial than at present there is no reason for abuse of what we already have. The underground conduit has been tried with very indifferent results; the storage battery, promising as such experiments as those recorded in the present issue show it to be, is as yet undeveloped, and if the public waits for an ideal system of electric traction to be devised it will have the pleasure in the interim of tramping through muddy streets and crawling along in dirty horse cars.

The Properties of Aluminium. PROF. CROCKER'S remarks on the aluminium problem, in a discussion before the American Institute of Electrical Engineers, which we publish elsewhere in our columns, are exceedingly pertinent. Perhaps no comparatively new substance has been so universally misunderstood and overrated. To aluminium bronze in particular is attributed all sorts of almost mythical properties, and these are confidingly ascribed to the aluminium contained in it. As a matter of fact aluminium bronze is not, properly speaking, an alloy of aluminium at all, but an alloy of that old and enormously valuable metal copper, with a certain proportion of a foreign ingredient that happens to be one of a group that greatly improve its mechanical properties. Small amounts of silicon and phosphorus, enormously less than the percentage of aluminium generally employed, confer upon copper properties almost as valuable. So far as experiments have gone, and the ground has been pretty thoroughly covered, the only alloy of aluminium that possesses strikingly valuable properties is that with silver. This compound, containing from one to five per cent. of the precious metal, is a true alloy of aluminum, and possesses in a very high degree the brilliant color and lightness of its principal constituent, combined with physical qualities that make it useful. Pure aluminium is not only, as Prof. Crocker says, too soft for structural purposes, but it is emphatically too soft for convenient working; it will not take a lasting screw-thread, scratches very easily, and softens so readily through heating as to be quite useless for many purposes. So far as has yet been ascertained, its most important application is in the formation of bronzes of good quality, but containing very little aluminium. The alloy with silver ought to come into extended use for all fancy articles of various descriptions that are now silver or nickel plated and for purposes where lightness is an essential quality; in this respect aluminum-silver is far better than the pure metal, inasmuch as its specific gravity in nearly the same and its strength greater. For electrical purposes it is difficult to foresee any brilliant future for the metal in question. In the first place, lightness is not generally a valuable quality in conductors, and for equal conductivity an aluminium wire would have to be so much larger than a copper one that the cost of insulation and handling would be increased, even if the metal itself were as cheap. For use as trolley wire and similar purposes aluminium would have no particular advantage, for if used pure its tensile strength is unsatisfactory, and the alloy with silver is too expensive. So, altogether, although we have cheap aluminium, a vast deal of work needs to be done in searching out the proper field for its applications. Such an one it undoubtedly has, and it probably may be reached through the investigation of aluminium alloys, but the metal itself is not a promising material for practical use.

The Storage Battery Again. IT is a pleasure to be able to chronicle even the appearance of success in storage battery traction. Hope has been so often deferred in this particular matter that one grows intensely skeptical of any alleged results that are brought to light. On another page, however, will be found an account of a new system of storage battery traction that at least promises better things than have up to the present time been obtained. The chief peculiarity of the new system is the use of an improved form of the alkaline storage battery instead of the old lead accumulators that have been a constant source of trouble and expense to those who have undertaken to use them for traction purposes. The alkaline accumulator suffers under the disadvantage of a low voltage, but to compensate for this it is considerably lighter than the ordinary storage cells for the same output. It is free from the tendency to buckling that has made economy in the use of lead accumulators so hopeless, and still better, the chemical actions in it are comparatively simple and are found to be almost completely reversible, so that the tendency to deterioration is very small. Its adoption has enabled Messrs. Waddell and Entz, the inventors of the system under discussion, to reduce the weight of battery required for a 50-mile run to 3,000 pounds instead of the four or five thousand which have usually been employed in cars operated by the ordinary batteries. The motor of the new car also possesses some striking peculiarities; it has a very large Gramme armature with internal field magnets; it is multipolar, and the armature speed is sufficiently low to permit of the use of a single reduction gear. Furthermore, the motor is arranged to be reversed and to operate as a charging dynamo while the car is running down grade or stopping. In this way a certain proportion of the energy spent on the car is recovered, not a large fraction, probably, but still enough to be worth saving. The experimental trips of the new car have been unusually successful, and give promise of commercial practicability, which is more than can ordinarily be said of storage battery cars. There is apparently no reason why the plates of the battery should deteriorate to any considerable extent, and thus the cost of renewals, perhaps the most formidable factor in previous attempts, is brought to a reasonable figure. The secret of success probably is, after all, the lightness of the whole car equipment, thus greatly reducing the amount of power necessary to operate the car. In this respect the Waddell-Entz car compares favorably with those designed for operation on the ordinary trolley system. In striving after other things designers of traction mechanisms have too frequently forgotten that every extra pound of weight means an additional hole in the coal pile. While it is too early to make definite predictions as to the success of traction by the alkaline batteries, it is at least safe to say that the system is unique in its combination of light weight with general working efficiency.

Latest Foreign Electrical News.

(By cable from our regular correspondent.)

London, May 11, 1891.—At the meeting of the Institution of Electrical Engineers, on Thursday last, Prof. J. A. Fleming, perhaps our best-known authority on alternating-current apparatus, read a valuable paper giving the complete mathematical theory of the Ferranti effect as exhibited in the Deptford mains. This curious result of employing underground cable of large static capacity has proved to be rather a puzzler for most electricians, and all sorts of theories have been advanced. Prof. Fleming's treatment of the subject, however, was complete, and is a most valuable addition to our knowledge. After the conclusion of his paper Mr. W. H. Preece, chief electrician of the postoffice, mentioned some interesting points connected with electric-lighting mains, and devoted particular attention to the various earthing arrangements adopted at the Deptford central station.

On Wednesday the conversazione of the Royal Society was held, and proved to be a most brilliant affair, and included a large show of electrical apparatus. A very large number of prominent electricians were in attendance.

The municipal authorities seem to be gradually coming over to electric lighting in a way that is most encouraging. A sub-committee of the Glasgow corporation has just recommended that the municipality should expend £60,000 on the electric lighting of the city according to the plans laid down by Sir William Thomson. More than this, the local authorities of South Staffordshire have persuaded themselves of the value of electric traction and approve the adoption of electricity in the place of steam for motive power on the connecting lines in that district.

Some interesting scraps of news have come from the Continent. The trials of the Sims-Edison electric torpedo in the port of Havre excited a great deal of admiration. The torpedo performed the most intricate evolutions at a high rate of speed, and showed itself to be directly under control from the shore operator. In Paris last week a central station on the five-wire system was opened, and thus far has given an excellent account of itself. In Italy the Florence-Fiesole Sprague electric tramway has been reopened It will be remembered that about a year ago a very serious accident on the line aroused public fear and indignation, and interfered with further operations.

The electrical exhibition at the Crystal Palace that has been talked of for some time is announced for next November.

NEW BOOKS.

Universal Wiring Computer. By Carl Hering. Pp. 44, tables and illustrations. New York: The W. J. Johnston Co., Ltd., 1891. Price, $1.00.

Of incandescent wiring handbooks and tables there are many, most of them, however, somewhat limited in their applicability and lacking in important details. The present volume is rather a new departure, and the wiring charts in it are by all odds the most compact and convenient that we have seen. A brief synopsis of general distribution of wiring and of wiring formulæ accompanies the charts, besides the formal explanations for use. The remainder of the book is taken up with a series of very useful wiring tables, giving an immense number of details concerning wire and its properties that will be found exceedingly useful to the practical man. They can, of course, be used for power wiring by a mental reduction to an equivalent number of lamps, and will otherwise make themselves generally useful in all sorts of miscellaneous problems.

American Electrical Directory for 1890-91. Star Iron Tower Co., Fort Wayne, Ind. Price, $5.00.

This directory is intended to be a complete list of all the central stations in the country, giving the officers, capacity, and details of every electrical central station now in operation. Besides this it has a very extensive list of isolated plants and a separate list of electric railways. Some tables and miscellaneous information are added, to make, on the whole, a rather complete directory of electrical current producers all over the country.

Obituary.

At the last meeting of the American Institute of Electrical Engineers the secretary read the following obituary notice, which is to be incorporated in the *Transactions* of the Institute:

Thomas P. Conant was born July 11, 1860, at Paris, France. He was carefully educated, and graduated at Columbia College School of Mines as a mining engineer in 1882. He then became Mr. Edison's secretary, and subsequently served in the construction department of the Edison company, where he continued two years. He gained further electrical experience with the United States Illuminating Company and the Bradley Electric Power Company. After an engagement of one and a half years with the Electrical Accumulator Company he re-entered the Edison service in August, 1889, and was appointed engineer of the eastern district of the Edison General Electric Company, a position which he occupied at the time of his death, which occurred on Feb. 24, 1891, at the home of his grandfather, the Rev. Dr. T. J. Conant, in Brooklyn. Mr. Conant was elected an associate member of the American Institute of Electrical Engineers, Nov. 1, 1887, and was transferred to full membership Jan. 3, 1888. He was also a member of the American Society of Mechanical Engineers, the Electric Club, the Manhattan Athletic Club and other associations. In his leisure moments he devoted much time to literature, and several poems from his pen have appeared in *Harper's Magazine* and other periodicals. He made several improvements in secondary batteries and their application, patents for which were assigned to the Electrical Accumulator Company.

The Coming Meeting of the American Institute of Electrical Engineers.

In addition to the programme given in the last issue of The Electrical World, it may be stated that ladies are invited to the lecture to be given by Mr. Tesla on Wednesday evening.

The New York Electric Club has courteously extended to the Institute the full privileges of the club house, 17 East 22d street, during the period of the meetings. Thursday evening at 8 o'clock a reception will be tendered to the Institute at the club house. Special interest will be given to this reception by reason of the fact that the entertainment committee of the Club has arranged for a loan exhibition of early electrical books, apparatus, models and paintings.

A Promising Storage Battery System.

Accumulator cars have been appearing with a certain wearisome periodicity ever since the experiments of Faure evolved the modern storage battery. It is so seldom, however, that one can conscientiously say anything good of them that an occasion like the one about to be described is a somewhat noteworthy event in electrical circles. On Monday, May 4, a public test of the Waddell-Entz storage battery car was held in Philadelphia, and its success was so unusual as to attract very widespread attention. The inventors of the apparatus, Messrs. J. B. Entz and Montgomery Waddell, of New York, have been working quietly along, making experiments for the past year, and have made some preliminary tests with a car equipped with their devices on the Brooklyn & Coney Island road. About a month ago the car was put on one of the Philadelphia lines near Germantown Junction, and has been undergoing a series of experiments ever since. These have been so successful as to warrant the public exhibition that has just been held.

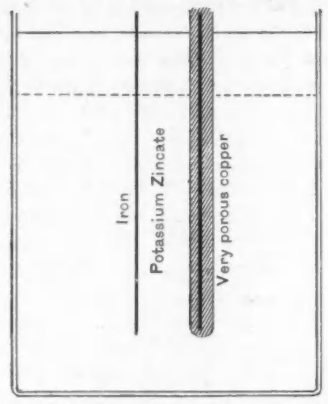

Fig. 1.—Waddell-Entz Storage Cell.

Unlike most storage battery cars, something more was involved in the present one than a storage battery warranted not to buckle and a motor of crude and unusual design. The features of the Waddell-Entz apparatus are three: First, the use of an alkaline accumulator; second, the employment of a particularly light slow-speed motor; and, third, practical arrangements for utilizing the motor as a dynamo on down grades to recover a certain proportion of the energy used in storing the battery. Nearly all the work that has been done on accumulators has been devoted to the lead type, in which the electrodes are leaden grids of infinitely various forms packed in one way or another with oxides of lead. The electromotive force of such cells is high, as every electrician knows, between 2 and 2.4 volts per cell; but the weight is enormous and the durability anything but what could be desired.

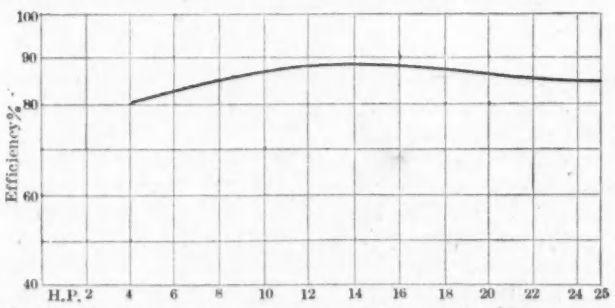

Fig. 2.—Efficiency Curve of the Waddell-Entz Motor.

The deterioration of lead storage batteries occurs partially through irreversible chemical processes going on in the cell, and also through the mechanical action produced by these chemical processes on the active material of the plate, the result being that the grids are, from a swelling and distortion of the plugs of active material within them, twisted out of shape so that the battery is short circuited. This fault occurs in the positive plates and is known as buckling; it is the peculiar difficulty with ordinary storage batteries. Whenever one attempts to force the output of a cell and draw from it an unusually large current, the result is a tendency to buckle the plate; and when, as in street-car work, severe demands are made upon the battery many times in the course of a trip, the effect is disastrous, and a very few months is found to destroy the usefulness of the cell, either through buckling, or through disintegration of the active material.

In experiments carried on by a very large number of people all over the world during the last decade, the uniform fate of positive plates has been found to be rapid disintegration as soon as they were put to any severe service. Of course, there have been occasional exceptions; but the fault is so general as to be well nigh universal, and has its origin in the nature of the chemical actions in the cell and their effect upon the physical characteristics of the active material. The weight of the average lead accumulator is about 100 pounds per h. p. hour stored, and the efficiency under ordinary conditions somewhere near 80 per cent., this latter depending almost entirely on the rates of charge and discharge, and the care that is taken of the cell.

The inventors of the system under discussion, for reasons like those enumerated, avoided the lead type of battery and adopted a very promising kind of accumulator that sprung into notoriety in France some two or three years ago; this is the alkaline accumulator brought out by Desmazures and his associates. It is, chemically, strikingly similar to the Lalande-Chaperon battery, known here with slight modifications as the Edison-Lalande. The alkaline accumulator has for its two metallic elements copper and zinc, and for the electrolyte caustic potash. The zinc is deposited upon iron electrodes, while the copper is exceedingly porous and capable of very ready oxidation.

Fig. 1 shows in diagram the character of the cell. The solution of the cell is really potassium zincate. The action on charging is to deposit metallic zinc on the iron electrode, which latter is generally in the form of a tinned gauze, and to oxidize the porous copper. On closed circuit the zinc is dissolved with the formation of potassium zincate and the oxide of copper is reduced. A porous partition is placed between the two elements, originally made of parchment paper. The electromotive force of such a couple is small, .8 to .9 of a volt, but the chemical action is almost completely reversible and the output very great in proportion to the weight.

The Desmazures accumulator was made with a plate of copper obtained by the compression of copper dust, giving a consistent mass, though the result showed it somewhat lacking in the necessary porosity. The batteries were adopted by the French government for the important experiments carried out on submarine torpedo boats, and furnished the power for the operation of the "La Gymnote" that made something of a sensation in the naval world a little over a year ago. The outcome of a great deal of experimentation showed that the efficiency of the alkaline battery was practically the same as that of a lead battery, while its weight could be easily reduced to a point unapproachable by any practicable form of the old accumulator. The weight of the alkaline accumulator per h. p. hour proved to be from 55 to 60 pounds, and there was nothing like the buckling that has proved so fatal to the positive plates of ordinary storage batteries. Such is the battery that Messrs. Waddell and Entz took up with a view to reducing it to a thoroughly practical form. Difficulties of a serious nature have been found with it, notably a great increase in resistance of the copper positive plates after a little use, and a serious amount of local action on open circuit. These great faults have been in a very large measure eliminated; the first by the employment of vastly more porous copper than was used by the French experimenters, thus allowing freer access to the reducing agent and preventing the irreversible oxidation that had before been found.

The second difficulty was in the original Desmazures battery due largely to defects in the parchment paper envelope, which in the present case is replaced by a textile one that gives vastly better results. In the Entz battery, too, the porous copper is furnished with a permanent backing of dense copper that is entirely unaffected in the action of the cell, and consequently keeps up the conductivity. Fig. 1 shows in diagram the general character of the resulting cell. The copper electrode is made with a dense copper core surrounded by exceedingly porous copper, and the whole inclosed in a textile covering; the liquid is potassium zincate, and the other electrode is of iron, permitting the deposition of the zinc. As a matter of fact, numerous plates are employed in each cell, just as in the ordinary lead battery, and the walls of the cell itself are of iron, and form a portion of the negative pole.

The result of these small but important changes made by the American inventors is a battery that, like its prototype, weighs about 55 or 60 pounds per h. p. stored, has an efficiency equivalent to that of the best lead storage batteries, and a power of resisting enormous discharges and working under very severe conditions that is unequaled, so far as we know, by any of the earlier types. Apparently, the faults of the Desmazures battery have been successfully overcome. In the car used in Philadelphia, 100 battery cells, weighing, complete and filled, 30 pounds apiece, and each $5 \times 7 \times 11$ inches were employed, giving from 75 to 80 volts at normal output. This battery is capable of delivering as high as 300 ampères without the evolution of gas or serious heating. It is stored under the

seats of the car, as is the usual practice, and is, for the purposes of governing and recharging, divided into several sets of cells. It will thus be seen that the battery equipment is very light, weighing, as it does, only about 60 per cent. as much as a lead battery of equal capacity. The gain in weight of battery per car is something like 1,500 pounds; the car is driven by a single carefully designed low-speed motor. It is of unusual design, inasmuch as the armature is a Gramme ring with internal fixed field magnets; the latter are magnetized by a single coil around a central shank. Two four-armed spiders upon the ends of this give the alternating north and south poles; the ring armature is 21½ inches in diameter over all and has a depth of core of about 1½ inches. It is wound, of course, with a heavy wire, for it is designed for a low voltage and large quantity of current. There are four carbon brushes, the several portions of the armature being thrown in parallel with each other; the whole is inclosed in a frame of non-magnetic material. Fig. 3 gives an excellent idea of the appearance of the machine and the methods of its support, one side of the frame being supported on the axle shown by dotted lines, the other upon a transverse beam on the truck, also shown by dotted lines in the cut. The armature speed for a car speed of 10 miles is about 450 revolutions per minute, and the power is transmitted to the axle through a single pair of gears, the speed reduction being about five to one. The armature pinion is case-hardened and acts on a wooden axle gear, so that the car runs very quietly. The advantages of this peculiar type of motor are in the large and well ventilated armature, giving a powerful torque, and permitting the use of very heavy currents without excessive heating; and, geared is in itself a decided advantage, as it both increases the commercial efficiency by avoiding multiplicity of gears and also reduces the working weight of the equipment. The motor and the regulating devices together weigh less than 1,500 pounds, with the result that the total weight of batteries, motor and regulating appliances in this Waddell-Entz car is less than that of the motor equipment of the standard cars used on the trolley system. This means a very decided saving in power, for one of the besetting sins of the storage battery system has been the excessive weight of equipment, every extra pound of which meant extra coal burned at the power station. Of course the same or similar motors could be used for the trolley system if desired, although such has not been the usual practice. The total weight of the copper in the motor is 130 pounds, a very satisfactory result for a motor intended for such exceedingly heavy currents. The regulating appliances of the car are interesting. The platform switch has six steps. Of these the first throws on the batteries, four in multiple, to start the car, the second changes this arrangement to two in multiple, the third throws all the cells in series, while the fourth and fifth cut out sections of the field, and the sixth reverses the motor on its lowest speed. The motors when the car is running down hill can operate as dynamos and restore energy to the batteries. This feature of the system is of practical use of course only on roads with perceptible grades, but under such circumstances it is undoubtedly somewhat effective, possibly saving as much as 10 per cent. of the energy. The road over which the trial trip was made is almost exactly three miles in length, giving a six-mile round trip for the car, and the power required to charge the batteries for the work is very nearly six horse-power hours, practically one horse-power hour per car mile. The total capacity of the batteries is of course much greater than this, sufficient for perhaps half a day of ordinary service. This result of one horse-power hour per car mile at the power station is immensely satisfactory; it is unquestionably better than has been usually obtained by storage battery cars, and compares very favorably with the output shown just mentioned. Fig. 5 shows a view of the complete car with which the experiments were made, and Fig. 4 a diagram of the output required at each point of the test run over the road. The readings were taken with Weston ammeters and voltmeters each ten seconds, and the result shows clearly the ability of the batteries to stand a very heavy output without serious drop in their power. The portions of the curve below the axis represent, of course, periods during which energy was being restored to the battery. It will be seen that the running speed in this test was 10 miles per hour, the three miles being covered in 18 minutes. Altogether this alkaline storage battery motor system seems to be a very useful addition to the methods of electric traction, certainly the most promising that has appeared for some time in the way of proper equipment for city service. Of course, time alone will tell its success when operated by unskilled labor under adverse conditions, but the results obtained are certainly such as to warrant a considerable degree of encouragement to the advocates of storage battery traction.

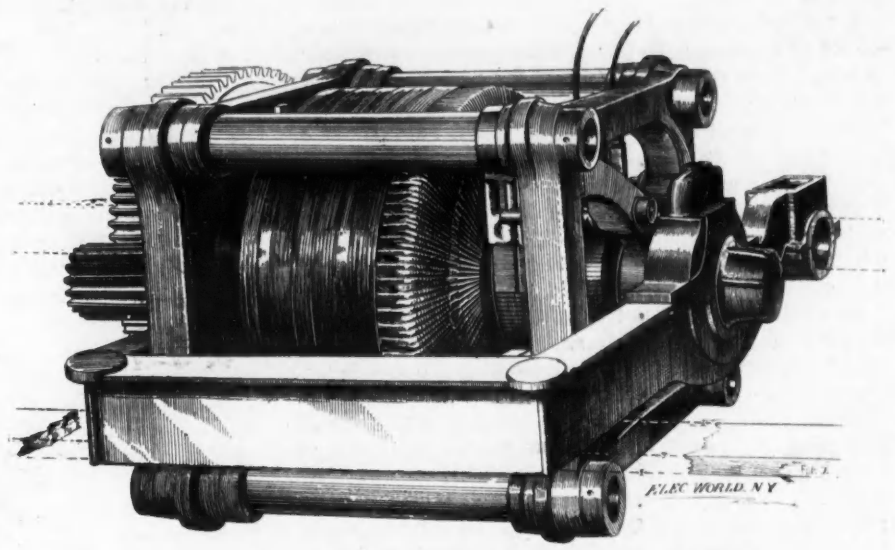

FIG. 3.—THE WADDELL-ENTZ STREET CAR MOTOR.

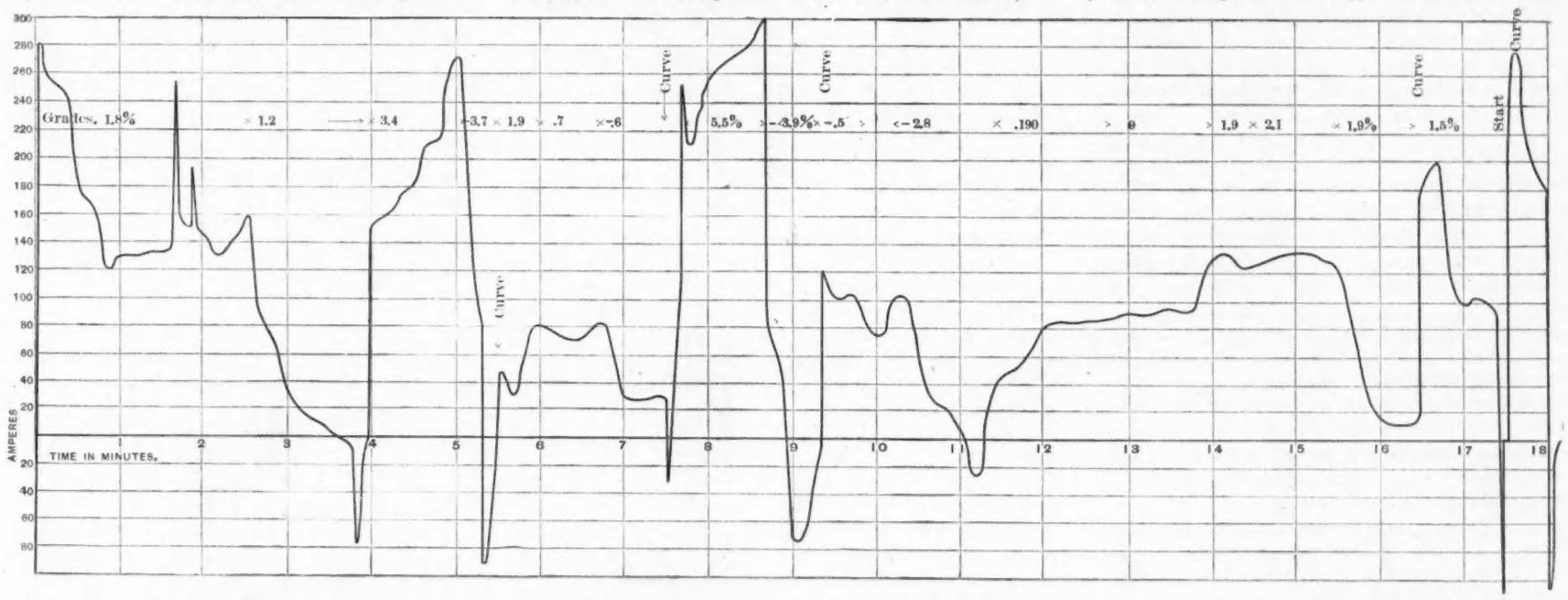

FIG. 4.—CURVE SHOWING THE CURRENT USED BY THE WADDELL-ENTZ MOTOR DURING A TRIP OVER A THREE MILE TRACK.

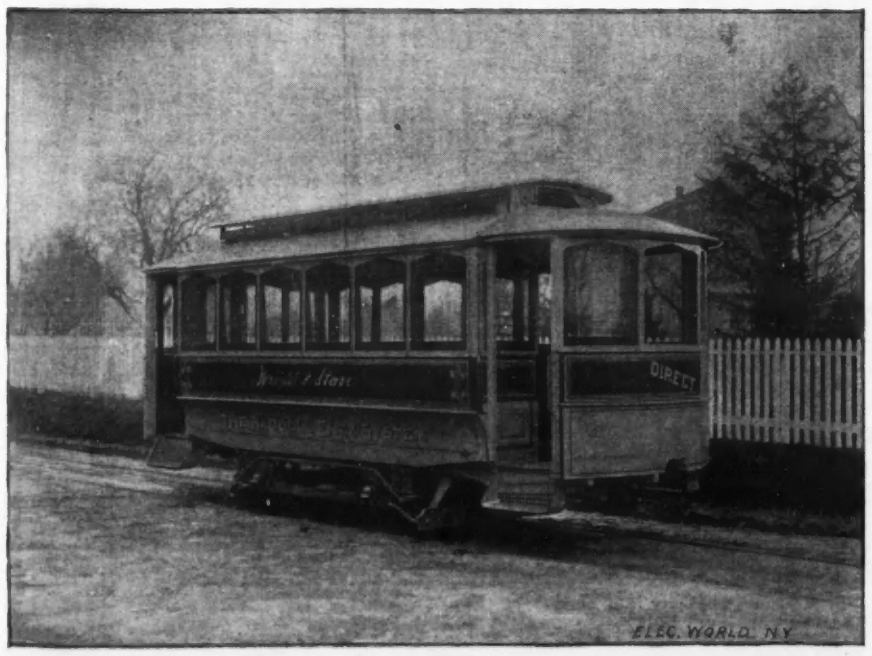

FIG. 5.—CAR EQUIPPED WITH THE WADDELL-ENTZ MOTOR.

machine was designed, however, to give its maximum efficiency at something like its average output. Fig. 2 shows its efficiency curve at various loads. The motor being nominally of 20 h. p., its point of maximum efficiency is at about 15 h. p., and even at 15 h. p., its normal load, the efficiency will be seen to be 80 per cent. This is not a remarkable figure, but it gives a good all-around commercial efficiency even under widely varying loads. The use of a single motor once second, in the simple form of the field magnets, enabling magnetism to be obtained with comparatively small expenditure of energy. The actual maximum efficiency of the motor is satisfactory without being phenomenal. The to be necessary on trolley roads, which, however, it should be said, have heavier grades and a heavier car equipment than the one we are considering. The trial trip was a thorough and complete success. The car ran smoothly and regularly, and its motion down grades was reported to be exceedingly easy, owing to the reversal of the motors and the braking action of their use as dynamos. In the same way stopping is accomplished within the length of a car, and very smoothly, owing to the device

Growth of Electric Lighting in Pittsburgh.

The publication of exact figures showing the growth of incandescent electric lighting from month to month and year to year in any one plant is of very great interest. The following table gives figures of this kind for the growth of the business of one of the most prominent central stations of the country, and one which is recognized by all central station men as an admirable example of central station construction and management, namely, that of the East End Electric Light Company, of Pittsburgh, Pa. The business of this company is largely that of residence lighting, at least 75 per cent. of its lights being of this character. The following table shows the exact number of incandescent lights connected in circuit each month since the organization of the plant on Jan. 20, 1886, up to the end of the year 1890. It will be seen that the number of lights now in circuit is a little over 20,000, and that of this number there have been connected during the five years named respectively 662, 1,041, 2,293, 7,512 and 8,626 lights. The system in use is the Westinghouse alternating, and Mr. G. P. Shane is the general manager and treasurer of the company.

	1886.	1887.	1888.	1889.	1890.
January	82	824	1,725	4,197	11,855
February	170	899	1,735	4,625	12,261
March	225	930	1,763	5,035	13,001
April	290	960	1,801	5,653	14,656
May	3 0	1,016	1,875	6,917	15,955
June	368	1,080	2,052	7,831	16,632
July	440	1,103	2,120	8,535	17,107
August	500	1,240	2,350	8,867	17,878
September	530	1,361	2,453	9,416	18,242
October	595	1,583	2 696	10,243	19,072
November	622	1,690	3,385	10,968	19,328
December	662	1,703	3,996	11,508	20,134

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1271–1295.——Polo (Marco), Paulus Venutus, is reported by many to have brought the compass from China to Italy. This is, however, supported by no evidence nor is any allusion whatever made to the fact in the account he rendered of his voyage. Before Marco Polo set out on his travels, as De Humboldt states, the Catalans had already made voyages "along the northern islands of Scotland as well as along the western shores of tropical Africa, while the Basques had ventured forth in search of the whale, and the Northmen had made their way to the Azores (the Bracir islands of Picigano)."

Polo relates that he set out from Acre in 1271, and returned to Venice "in the year 1295 of Christ's Incarnation." His "Travels" ("Il Milione di Messer, Marco Polo"), according to the review of Col. Henry Yule, consists of a prologue and four books. It was dictated by him to a fellow prisoner, Rusticiano or Rusticello, of Pisa, and "it would appear now to be definitely settled that the original was . . . of just such French as we might expect in the thirteenth century from a Tuscan amanuensis following the oral dictation of an Orientalized Venetian."

Polo's journeyings extended "so far to the north that he leaves the North Star behind him, and thence so far to the south that the North Star is never seen."

See Becquerel, "Elec. et. Mag.," I., p. 70; Sonnini, in Buffon, "Minéraux," VI., p. 84; "Cosmos," vol. II., pp. 625, 656 and vol. V., p. 53; Azuni., "Boussole," p. 69.

A. D. 1272.——Lully (Raymond), of Majorca, "the singularly ingenious and eccentric man whose doctrines excited the enthusiasm of Giordiano (Jordano) Bruno when a boy, and who was at once a philosophical systematizer and an analytical chemist, a skillful mariner and a successful propagator of Christianity," writes his "De Contemplatione," which is followed by "Fenix de las maravillas del orbe," in 1286, and by his "Arte de Naveguar," in 1295. In these, he states that the seamen of his time employed instruments of measurement, sea charts and the magnetic needle (*tenian los mareantes instrumento, carta, compas y aguja*), and he describes the improvements made in the astrolabes (designed for the determination of time and of geographical latitudes by meridian altitudes and capable of being employed at sea) from the period that the astrolabium of the Majorcan pilots was in use.

Lully also confirms the fact that the Barcelonians employed atlases, astrolabes and compasses long before Don Jaime Ferrer penetrated to the mouth of the Rio de Ouro, on the western coast of Africa, which was about 50 years after the date of the last-named work.

Incidentally, it may be added that Lully is said to have in the presence of King Edward I. converted iron into gold, which latter was coined into rose-nobles (Bergman, "Hist. of Chemistry").

See "Cosmos," vol. II., pp. 629, 630, and vol. V., p. 54; Miller, "History Philosophically Illustrated," London, 1849, p. 217 and note.

A. D. 1282.——Baïlak, native of Kibdjak, wrote this year in Arabic his book on Stones, wherein he says that he saw during his voyage from Tripoli to Alexandria in 1242 the captains of the Syrian sea construct a compass in the following manner: "When the night is so dark as to conceal from view the stars which might direct their course according to the position of the four cardinal points they take a basin full of water, which they shelter from wind by placing it in the interior of the vessel; they then drive a needle into a wooden peg or a corn-stalk so as to form the shape of a cross, and throw it into the basin of water prepared for the purpose, on the surface of which it floats. They afterwards take a loadstone of sufficient size to fill the palm of the hand, or even smaller; bring it to the surface of the water, give to their hands a rotatory motion towards the right so that the needle turns on the water's surface; they then suddenly and quickly withdraw their hands, when the two points of the needle face north and south."

See *American Journal of Science and Arts*, XL., p. 247; Davis, "The Chinese," vol. III., p. 12; Klaproth, "Lettre, etc," pp. 59, 60, 67; Knight, vol. II. of "Mechanical Dictionary," pp. 1,371 and 1,397.

A. D. 1302.——Gioja (Flavio de), an Italian pilot born at Positano, near Amalfi, is said by Flamminius Venanson "De l'Invention de la Boussole Nautique," Naples, 1808, pp. 138 and 168) to be the real inventor of the mariner's compass. This view is supported by Briet (Philippe) "Annales Mundi," 1302, t. 6, "Geog. et Hydrog.," lib. 10, cap. 8); by Voltaire ("Essai sur les Mœurs," 1819, vol. III., chap. 141) and by many others, but Klaproth ("Lettre, etc.," 1834, pp. 132–136) shows that Gioja cannot well have invented an instrument constructed more than 100 years before him.

In his "Navigators' Supply," published 1597, William Barlowe speaks of "the lame tale of one Flavius, at Amelphus in the Kingdome of Naples; for to have devised it (the compass) is of very slender probabilitie."

D. A. Azuni says ("Boussole," 1809, p. 144) that Gioja may have possibly invented the method of suspending the magnetic needle upon a perpendicular pivot so that it would remain horizontal whatever the movements of the vessel. This is very likely; at any rate it must be admitted that this particular mode of support permits a freer movement to the needle in any direction and admits of more exact observations than when the needle is floating upon the water.

See Venanson pp. 158, 160; Knight "Mechanical Dictionary," vol. II., p. 1,398.

A. D. 1327–1377.——It has been claimed by F. M. Aroute de Voltaire, who asserts it at vol. III., pp. 251, 252, of his "Essai sur les Mœurs et l'Esprit des Nations," Paris, 1809, that "the first well authenticated use of the compass" was made by the English during this period, which is that of the reign of King Edward III.

By Voltaire, the extraordinary (*prodigieuse*) antiquity of the Chinese is not questioned. They knew of the compass, but, he says, "it was not employed by them for its proper use, that of guiding vessels at sea. They traveled

FIG. 2.—COMPASS CARD AND GRADUATED RING, THE LATTER SHOWN AT *D*.

only along the shores. Possessed, as they were, of a country that furnished everything, they did not feel the need of going, as we do, to the other end of the world" (vol. I., pp. 239 and 247). Speaking of the Portuguese (vol. III., p. 257), he says: "It was not before known if the magnetic needle would point to the south on approaching the South pole; it was found to point constantly to the north, during the year 1486."

From the time of Edward III. the compass was known in England by the names of *adamant*, *sailing-needle* and *sail-stone dial*, as has been shown in the writings of Chaucer and others, the most important of which will be duly quoted in their order.

It may be well to record here that Voltaire was "confessedly the foremost name, the acknowledged head of European literature of his time." Goethe calls him "the greatest literary man of all time, the most astonishing creation of the Author of Nature." ("Nouvelle Biog.," vol. 45, 1, p. 445.) Though not the first French author who wrote on the wonderful discoveries of Newton, he was the first to make them extensively known on the Continent.

See Sir Harris Nicolas, "Hist. Roy. Navy," 1847, vol. II., p. 180; "Cosmos," vol. V., 56, note.

Regarding the Mariner's Compass, it can scarcely be doubted, from what precedes, that it came to the knowledge of Europeans in the manner indicated under the A. D. 1190 date.

Baïlak spoke of its use as generally well known by the Syrian navigators who constructed it in exactly the same

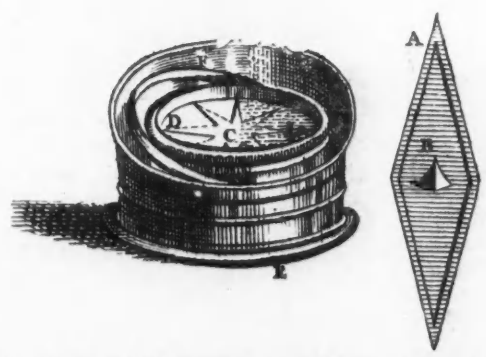


FIG. 1.—MARINER'S COMPASS OF THE FOURTEENTH CENTURY.

A, Needle; *B*, Hollow Cap for Poising Needle on its Pivot; *C*, Compass Card; *D*, Compass Rim; *E*, Box; *F*, Rim of Compass Box with Rings for Centring the Compass.

way as did the Chinese, A. D. 1111–1117, and which resembled the compass seen by Brunetto Latini in the possession of Friar Bacon while in England prior to the year 1260. (Knight, "Mechanical Dictionary," vol. II., p. 1,397.)

Edrisi (Idrisi or Aldrisi), the most eminent of the Arabian geographers, is said by Boucher to have given a confirmed account of the polarity of the magnet, the early knowledge of which by the Arabs has been shown conclusively by Jacob de Vitry, Vincent de Beauvais and Albertus Magnus.

In Dr. Plumptre's notes on Dante reference is made to the fact that the European knowledge of the magnetic needle came from Arabia, and, like De Humboldt, he quotes in support thereof an allusion from the Spanish "Leyes de las Partidas," belonging to the first half of the thirteenth century. The passage in the last-named is spoken of by Navarrete (M. Fern de) in his "Discurso historico, etc.," 1802 (II., tit. IX., ley 28), and reads thus: "The needle which guides the seaman in the dark night and shows him, both in good and in bad weather, how to direct his course is the mediatrix (*medianera* between the loadstone (*la piedra*) and the north star. . . ." De Humboldt adds: "See the passage in 'Las siete Partidas del sabio Rey Don Alonso el IX.' (according to the usually adopted chronological order Alonso the tenth), Madrid, 1829, t. 1, p. 473)."

On the other hand, the knowledge of the compass by the Arabs in the thirteenth century has been most decidedly contested by E. Renaudot ("Anciennes Relations des Indes et de la Chine," Paris, 1717, p. 3), D. A. Azuni ("Dissertation sur l'origine de la Boussole," Paris, 1809, pp. 102 and 127), and A. Collina ("Considerazioni, etc.," Faenza, 1748, p. 121, etc.). Buffon says ("Théorie de la Terre," Paris, An. VIII., tome I, p. 300): "I know that some pretend the Arabs have invented the compass and have used it long before the French (See "Abrégé de l'histoire des Sarrazins" de Bergeron, p. 119), . . . but that opinion always appeared to me devoid of reason; for there is no word in the Arabian, Turkish or Persian tongue which can be made to signify the compass. . . . They employ the Italian word *bossola*. . . ."

The same view is entertained by Dr. William Robertson, principal of the University of Edinburgh, who, after announcing in his "History of the Reign of Charles V.," London, 1769, vol. I., p. 78, that the mariner's compass was invented soon after the close of the Holy War, gives, at pages 333–335 of his "Historical Disquisition," London, 1812, a translation of the above passage taken from an early edition of that illustrious French naturalist George Louis Le Clerc, Comte de Buffon. Robertson adds: "This shows that the knowledge of this useful instrument was communicated to them (the Arabs) by the Europeans. There is not one single observation of ancient date made by the Arabians on the variation of the needle, or any instruction deduced from it, for the assistance of navigators. . . . When Mr. Niehbuhr was at Cairo he found a magnetic needle in the possession of a Mahommedan which served to point out the *Kaaba*, and he gave it the name of *el magnatis*, a clear proof of its European origin."

The claims of France to the discovery of the compass have been laid by some to the fact that the north point of the early instruments was generally drawn in the form of a *fleur de lys*, but Voltaire says ("Essai, etc.," vol. III, p. 251) that the Italians did this in honor of the sovereigns of Naples, a branch of the French royal family. The able writer in the English Encyclopædia ("Arts and Sc.," vol. III., p. 102) considers the design to be only "an *ornamental cross* which originated in devotion to the mere symbol; though, as the compass undoubtedly came into Europe from the Arabs, the *fleur de lys* might possibly be a modification of the *mouasala*, or dart, the name by which the Arabs called the needle."

See Hallam, "Middle Ages," vol. III., chap. 9, part 2; Klaproth, pp. 53, 54 and 64–66; "Cosmos," vol. V., p. 56; Davis, "The Chinese," vol. III., p. 12.

A. D. 1391.——Chaucer (Geoffrey), the father of English poetry, thus expresses himself in "The Conclusions of the Astrolabie" (English Poets, London, 1810, vol. 1.): "I have giuen thee a sufficient astrolabye for oure orizont compowned after the latitude of Oxenforde. . . . Now hast thou here, the fower quarters of thin astrolabie, deuided after the fower principall plages or quarters of the firmament. . . . Now is thin Orisonte departed in XXIIII parties by thi azymutz, in significacion of XXIIII partiez of the world; al be it so that shipmen rikne thilke partiez in XXXII."

> "Now maugre Juno, Aneas
> For all her sleight and her compas
> Atcheiued all his auenture."
> ("House of Fame," B. I.)

> "The stone was harl of adamaunt,
> Where of they made the foundemaunt,
> The tour was round made in compas,
> In all this world no richer was"
> ("Rom. of the Rose.")

> "Right as betwene adamants two
> Of euen weight, a pece of yron set,
> Ne hath no might to moue to ne fro
> For what that one may hale, that other let."
> ("Assem. of Foules.")

The compass is also alluded to by Fairefax, "Godfrey of Boulogne," b. XV., s. 18; Gower, "Confessio," books I. and VI.; Hackluyt, "Voyages," vol. I., pp. 213 and 215.

A. D. 1436.——Andrea Bianco published an atlas exhibiting charts of the magnetic variation. The knowledge of the latter so indispensable to the correction of a ship's reckoning was then determined less by the rising and the setting of the sun than by the polar star.

See "Cosmos," vol. V., p 54; Johnson's "New Universal Cyclopedia," 1878, vol. III., p. 230.

A. D. 1490–1541.——Paracelsus (Aureolus Theophrastus)—the assumed name of Philip Hochener Theophrastus Bourbast von Hohenheim—a native of Switzerland, admitted by unprejudiced writers to have been one of the great chemists of his time (Hemmann, "Medico-Sur. Essays," Berlin, 1778), made use of electromagnetism three centuries before Prof. Oersted's discovery. He rediscovered the occult properties of the magnet, "the bone of Horus," which, twelve centuries before his time, had played such an important part in the theurgic mysteries; and he very naturally became the founder of the school of magnetism and of mediæval magico-theury. But Mesmer, who lived nearly three hundred years after him, and, as a disciple of his school, brought the magnetic wonders before

* Continued from THE ELECTRICAL WORLD, May 9, 1891.

the public, reaped the glory that was due to the fire-philosopher, while the great master died in want. ("Isis Unveiled," vol. I., pp. 71, 72, 164.)

Madam Blavatsky further adds: The full views of Paracelsus on the occult properties of the magnet are explained partially in his famous book "Archidaxarum," wherein he describes the wonderful tincture, a medicine extracted from the magnet, and called "Magisterium Magnetis," and partially in the "De Ente Dei" and "De Ente Astrorum," liber I. . . . "Every peasant sees," says he, "that a magnet will attract iron, but a wise man must inquire for himself. . . . I have discovered that the magnet, besides this visible power (that of attracting iron), possesses another and *concealed* power." (See "Isis Unveiled," vol. I., pp. 165–170; also biography of Paracelsus in Larousse, "Dict. Univ.," vol. XII., pp. 171, 172, and in the Ninth Britannica, vol. XVIII., pp. 234–236.)

Alternating Current Electric Motors.—II.

BY DR. LOUIS DUNCAN, JOHNS HOPKINS UNIVERSITY.

To turn from an example of class I. to the best example of class II. of alternating motors, I will try to discuss the novel and admirable machine invented by Mr. Tesla.

The problems involved are not very different from converter problems, and I confess that I approach them with something of ill-humor. I evolved the calorimeter method* of testing transformers, and it has been absorbed by an eminent English electrician; with Messrs. Wilkes and Hutchinson I produced† a method for obtaining simultaneous current and E. M. F. curves in the primaries and secondaries of converters. Another set of experimenters has since used the method and appropriated the credit. These are small matters, but they cause irritation. I imagine the results were somewhat too early. The editor of an electrical periodical, in reproducing one of the irregular primary curves (see the paper referred to, or Prof. Ryan's work), remarked on the singular want of symmetry in the construction of our dynamo.

In its simplest form the Tesla motor consists of an armature rotating in a magnetic field, which is the resultant of two fields at right angles to one another, excited by two alternating currents differing in phase by $\frac{\pi}{2}$. The resultant field rotates with a period equal to that of the exciting currents. The armature coils are short-circuited on themselves, and currents are induced in them in a direction to cause the armature to rotate with the field. Let us consider the simple case of a Tesla motor without iron, the armature of which has a large number of coils on it.

Let the two fields be as shown in Fig. 4, and let one of the armature coils make an angle α with the horizontal. We will consider what takes place in this coil. We have in the first place an E. M. F. due to the induction of the two circuits 1 and 2, and in the second place a counter E. M. F. due to the motion of the coil in the fields of 1 and 2. The current is of course due to the difference of these two E. M. Fs. and the energy transformed is the product of the current and the counter E. M. F.

Let

i_1 = current in field 1.
i_2 = " " 2.
I = maximum value of current.
E_1 = E. M. F. induced in coil from 1.
E_2 = " " " " 2.
e_1 = counter = E. M. F. due to rotation in field of 1.
e_2 = " " " " " 2.
M = maximum mutual induction between coil and 1 or 2.

Then if

$i_1 = I \sin pt$, $i_2 = I \cos pt$, and if the induction varies with the current,

$$\left.\begin{aligned} E_1 &= M \cos\alpha \frac{di}{dt} = MIp \cos pt \cos\alpha \\ E_2 &= M \sin\alpha \frac{di_2}{dt} = MIp \sin pt \sin\alpha \end{aligned}\right\} \left\{\begin{aligned} &E_1 + E_2 = MIp \\ &\cos(pt-\alpha) = E. \end{aligned}\right.$$

$$\varepsilon_1 = -MI \sin pt \sin\alpha \frac{d\alpha}{dt}.$$

$$\varepsilon_2 = -MI \cos pt \cos\alpha \frac{d\alpha}{dt}.$$

Now $\frac{d\alpha}{dt}$ is equal to $\frac{2\pi}{T^1}$, where T^1 is the time of revolution of the armature; so we may put the above, p^1 being equal to $\frac{2\pi}{T^1}$.

$$\left.\begin{aligned} \varepsilon_1 &= -MIp^1 \sin pt \sin\alpha \\ \varepsilon_2 &= -MIp^1 \cos pt \cos\alpha \end{aligned}\right\} \quad \begin{aligned} &\varepsilon_1 + \varepsilon_2 = -MIp^1 \cos \\ &(pt-\alpha) = \varepsilon. \end{aligned}$$

Adding all these E. M. F's. and noting that α may be determined by $\alpha = p^1 t$ if our zero time be properly chosen,

$$E_1 + E_2 + e_1 + e_2 = MI\,(p-p^1)\cos(p-p^1)\,t = e_0.$$

The maximum value of the current due to this E. M. F. is $\frac{MI(p-p^1)}{(R^2+(p-p^1)^2L^2)^{\frac{1}{2}}}$, where R and L refer to the coil under discussion. The total energy transformed is $\frac{1}{2}\frac{\varepsilon_0 M^2 I^2 p^1 (p-p^1)}{(R^2+(p-p^1)^2L^2)^{\frac{1}{2}}}\cos\theta$, where $\tan\theta = (p-p^1)\frac{L}{R}$.

The energy used in heating is $\frac{1}{2}\frac{M^2I^2(p-p^1)^2}{R^2+(p^1-p)^2L^2}R$, and the armature efficiency is $\frac{p^1}{p}$. This last is true because the applied and counter E. M. F's. are 180 degrees different in phase, and they are therefore equally distant from the current. If we multiply the maximum values of E and e by one-half the maximum value of the current and by the cosine of θ, we will have in the first case the electrical energy applied to the armature, and in the second the electrical energy transformed into mechanical energy. The ratio of these products—the angle being the same—is simply $\frac{p^1}{p}$.

Looking at the value of the total energy transformed, we see that as L increases both the increase of the impedance and the decrease of $\cos\theta$ will necessitate—for a given output—a decrease of p^1. This, of course, lowers the efficiency. As the expression for the output contains $p^1(p-p^1)$ it is evident that with no self-induction the maximum output is when $p^1 = \frac{1}{2}p$; the efficiency being 50 per cent. If the motor has a self-induction, however, it is easily seen from the equation that the maximum output is for a value of $p^1 > \frac{1}{2}p$; there is no need of giving the value.

The induced E. M. F. in the armature and the effective E. M. F. are in the same phase, while the counter-E. M. F. differs from them in phase by π. If there were no self-induction the armature current would follow the impressed E. M. F., and the condition of affairs would be the best possible, for the maximum current would fit in with the maximum counter E. M. F., as it should. The effect of self-induction is to shift the current back from its best position and decrease the output for a given heating effect. Now, the permissible current in a machine of this kind is entirely determined by heating effects; so the self-induction should be as small as possible. The ratio of the heating effect to the output of the motor is $\frac{p-p^1}{p}\frac{R}{\sqrt{R^2+(p-p^1)L^2}}$ sec θ. For a given current $\frac{p-p^1}{p}$ is proportional to R, and we seen that tan $\theta = (p-p^1)\frac{L}{R}$. It goes without saying that if R is decreased, the ratio given in the equation also decreases, and the efficiency and output of the machine increases.

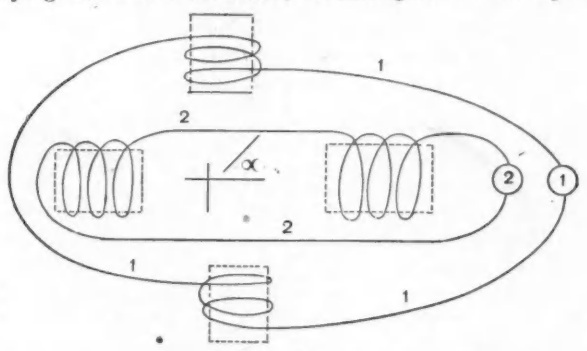


FIG. 4.—DIAGRAM ILLUSTRATING THE ACTION OF A TESLA MOTOR WITHOUT IRON.

Before discussing the matter further let us look at the armature actions in a different way. Consider a line whose azimuth is fixed and equal to α, and think of the condition of the coils in this azimuth. We have an applied E. M. F. equal, as we have seen, to

$$MIp \cos(pt - \alpha)$$

and a counter E. M. F. equal to

$$MIp^1 \cos(pt - \alpha).$$

As far as the line is concerned we have impressed on it—α is now fixed—an E. M. F. of period p instead of the period $p-p^2$ of the E. M. F. in a particular wire. But the current does not lag behind the E. M. F. by an angle $\theta = \tan^{-1} p\frac{L}{R}$, but by an angle $\theta = \tan^{-1} p-p^1\frac{L}{R}$, for we must remember that the wire which at any given instant has in it the maximum induced E. M. F. is rotating in the same direction as the counter E. M. F.; and when the current reaches its maximum it is closer to the counter E. M. F. by the angle through which it has rotated.

Comparing our results to those obtained in a transformer, we have an impressed E. M. F. in the moving wires which bears the ratio $\frac{p-p^1}{p}$ to the impressed E. M. F. that would exist if there were no rotation. In the same way tan θ is now $(p-p^1)\frac{L}{R}$, instead of $p\frac{L}{R}$, as it would be if the motor were still. Our current is $\frac{MI(p-p^1)}{(R^2+(p-p^1)^2L^2)^{\frac{1}{2}}}$, instead of $\frac{MIp}{(R^2+p^2L^2)^{\frac{1}{2}}}$. The result is the same as if we hold the motor and change its armature resistance in the ratio of p to $p-p^1$. As far as the transfer of energy from the field coils is concerned, we may reduce it to the case of two separate converters, each consisting of one pair of field coils for a primary, with a secondary made by winding one-half the armature coils at right angles to the magnetic field of the primary, the magnetic circuit being that corresponding to the pair of coils we are considering. There is no reason that the efficiency should not be high. The secondary of this converter may be considered to have in its circuit a non-inductive resistance equal to $\frac{p}{p-p^1}R$.

To take a specific case—and it is hard to find data on the subject—in the paper by Messrs. Hutchinson, Wilkes and myself referred to above, I find for a Westinghouse 10-light converter the following figures: Resistance of primary, 50 ohms; of secondary, .1 ohm; self-induction of primary, 1.96 henrys; of secondary, .0047 henrys. Under these circumstances, if our motor had the same constants we would have as a first approximation $\frac{p}{p-p^1} = 50$ (I suppose 50 volts and 10 ampères). If there are 100 periods per second, $\theta = \tan.^{-1}(p-p^1)\frac{L}{R} =$ about 30°, or the "plant efficiency" (= cos θ) is about 86 per cent. This being the case, p^1 would be less than the value assumed, and further approximations would increase the efficiency. I need not remark that the case chosen is a favorable one. The period chosen is impossible for a practical machine, and a lower one would be less advantageous.

Now let us consider what will happen if we increase all the linear dimensions of our machine. If we have a turn of wire around an iron ring, and increase the dimensions of the ring, both the self-induction and resistance will increase in the same proportion; that is, directly with the linear change. For if we suppose the permeability of the iron constant, the magnetic force due to a unit current in the wire would decrease in the ratio $\frac{1}{e}$, while the area inclosed by the wire would increase as l^2; the self-induction would therefore increase as l, which is of course a well-known fact. But in the case of our motor, as we increase the diameter of our armature we increase the space which our wire occupies; and keeping the same thickness of winding and the same number of turns we increase the area of our wire l times and therefore decrease its resistance by the same amount. But if all the linear dimensions of the motor have increased, our thickness of wire can increase, so our resistance will again decrease by l. Our self-induction has increased l times; our resistance has decreased by the same amount. If we now decrease the number of turns in a coil n times, both L and R decrease as n^2. If we let the speed of our motor vary inversely as its dimensions, and the induction remains constant, then for the same E. M. F. $n = l$, and L varies finally as $\frac{1}{l}$ and R varies as $\frac{1}{l^2}$. The ratio of L to R increases as our output increases, the increase being as l^2. To take a specific case; in the example cited above, if we double the dimensions of the motor we had imagined as corresponding to the transformer whose data were given, then on the assumptions we have just made, if the output be increased eight (2^3) times the percentage loss in the armature will not be changed. This being the case $p - p^1$ is 2 (2π) as before; but at the same time $\frac{L}{R}$ has four times its old value; so the tangent of the angle θ is four times as great for the small motor. Practically we would not care to reduce our speed as much as we have imagined.

The Tesla motor is in reality very nearly a synchronous motor—not that I consider the fact much of an objection—and like all synchronous motors there are times when its coils act as dynamo coils, thereby reducing its efficiency and output. The speed may be decreased by increasing the number of poles, but it always bears an approximately fixed ratio to that of the dynamo. We cannot, however, run on one circuit a number of motors at an indefinite number of speeds.

As compared with a continuous-current motor the armature efficiency and the output for a corresponding armature will be less. The iron in both field and armature is reversed—the former at a rate corresponding to p, the latter at a rate corresponding to $p-p^1$. The loss in the armature from eddy currents and hysteresis will be less than in a continuous current motor, but the loss in the field magnets would much more than counterbalance this gain, the mass of the magnets being usually much greater than that of the armature core. At the high periods that have been used the induction that could be economically used would be comparatively low. It would be interesting to know if the jarring of the machine, with the open magnetic circuit due to the air gap, materially decreases hysteresis losses. One of the most important of the practical objections to this motor is the fact that two independent circuits must be used to magnetize the fields, so it cannot be used on ordinary lighting circuits. I will refer to this in a moment.

The great advantages of the motor lie in the fact that it has no commutator, and it permits the use of very high voltages. In the future, power will be transmitted electrically at voltages that will make machines with the commutators next to useless, while the Tesla motor will offer many advantages for such transmission.

Since bringing out his first motor, Mr. Tesla, with great industry and ingenuity, has attempted to remedy the defects in the original machine. Perhaps the most serious of these is the inability to use the simple form of motor on ordinary alternating circuits. Mr. Tesla has attempted to get the required difference of phase between the magnetizing circuits, using a single circuit from the dynamo. I have no space to describe all of these; indeed they have already been described in the technical journals. The objection I have to most of them is that they cannot give a definite phase difference for different loads on the motor. Even the plan that has been proposed of using the primary of a converter for one magnetizing circuit, with the secondary as the other circuit, the latter having a condenser

*THE ELECTRICAL WORLD, 1887. It was copied in English journals at the time.
†THE ELECTRICAL WORLD, March 31, April 28, and May 19, 1888.

connected with it to neutralize its self-induction, will not work perfectly. For, even supposing a satisfactory practical condenser could be found, it must be remembered that the self-induction of the magnetizing coil will change as the load on the motor changes, so the phase of the magnetizing currents will not differ by $\frac{\pi}{2}$ except for some one load.

In another type of motor by the same inventor there are two sets of coils on one of the pairs of field magnet. One set is connected with the dynamo circuit; the other, in the relation of secondary to the first, is wound on the other pair of poles. A condenser or resistance will make the currents in the two circuits differ in phase by nearly $\frac{\pi}{2}$. This plan does not differ much from the one just described; the extra transformation is performed in the motor instead of in a converter.

Still another plan of Mr. Tesla is to take advantage of the fact that magnetization soaks gradually into a solid core as current soaks into a wire. Some one, writing in *Industries*, has denied this; it is, however, true, and he obtains a difference in phase between his magnetic fields from this fact.

Prof. Ewing's Theory of Magnetism.

BY ARTHUR HOOPES.

The "Theory of Induced Magnetism" which Prof. Ewing published in the *Philosophical Magazine* for September, 1890, is at once so beautifully simple and comprehensive that we have thought that some magnetization curves actually obtained from the model which he suggests might be interesting as testing, in some degree, the efficiency of the hypothesis. With this end in view the accompanying curves were determined by the writer, under the direction of Dr. Henry Crew, of Haverford College.

The magnets used were similar to those described by Prof. Ewing, about two inches long and balanced on sewing needles set in lead bases. They were 68 in number, and were placed in three layers or tiers on glass plates, which slipped into the magnetizing coil. The coil was 32 inches long and 12 in diameter, and was wound from end to end with 76 turns of wire. It was set with its axis east and west.

The magnetic moment of the model was measured by a magnetometer 34 inches from the middle of the coil. To eliminate the magnetic effect of the current in the coil, an opposing coil was adjusted on the other side of the magnetometer at such a distance that it just balanced the large coil when the magnets were out. The maximum strength of field used was about 2.7 C. G. S. units, or 15 times the horizontal component of the earth's field.

The method of obtaining the curves was simply to put in the magnets, stir them up and let them come to rest by themselves, then to vary the magnetizing current through a cycle and read the magnetometer deflections at intervals. As no attempt was made to get anything but the *shape* of the curves, the tangents of the magnetometer and galvanometer deflections were plotted on a convenient scale, without regard to the absolute values of current and magnetic moment.

Figs. 1 and 2 show curves obtained with the magnets as close together as they could be placed without striking. They illustrate well the different results that may be caused by different initial directions of the magnets. The magnet *centres* were in almost the same positions in the two cases, but in Fig. 1 the magnets took the directions shown in Fig. 3, while for the curve of Fig. 2 the original state is shown by Fig. 4. Both curves show beautifully the small susceptibility at first (*a* to *b*, Figs. 1 and 2), where the magnets are deflected through small angles, but have not yet passed through an unstable position. From *b* to *c* the magnets turned rapidly with small increase of current, and from *c* to the right they were brought more and more nearly into the direction of the axis of the coil, giving the flat part of the curve. On decreasing the current the curves almost retrace themselves to the point *d* directly above *c*, where stability begins. But here it leaves the ascending branch because it takes less strength of field to *hold* them in this position than it required to *put* them there. This state continues until the field is of nearly zero strength, when two or three magnets turn, giving the small drop at *e*. A slight negative increase turns many more, and another reverses every remaining magnet except four, which are almost exactly opposite to the direction of the field. In Fig. 1 the increase from *f* to *g* turned these four, but in Fig. 2 they were not affected by the strongest current that could be used. Consequently the curve of Fig. 2 is almost horizontal between *f* and *g*. The difference was probably due to a slight change in the position of the plate which supported these magnets. Completing the cycle, the upward branch of Fig. 1 is seen to consist of two main steps, while Fig. 2 has three, and both curves are to the right of the origin.

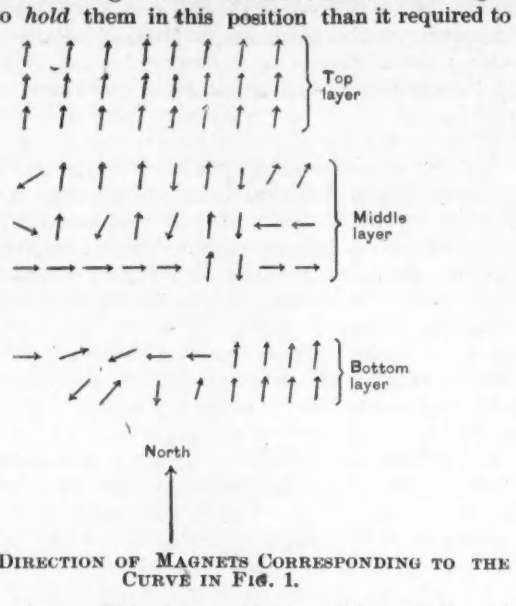
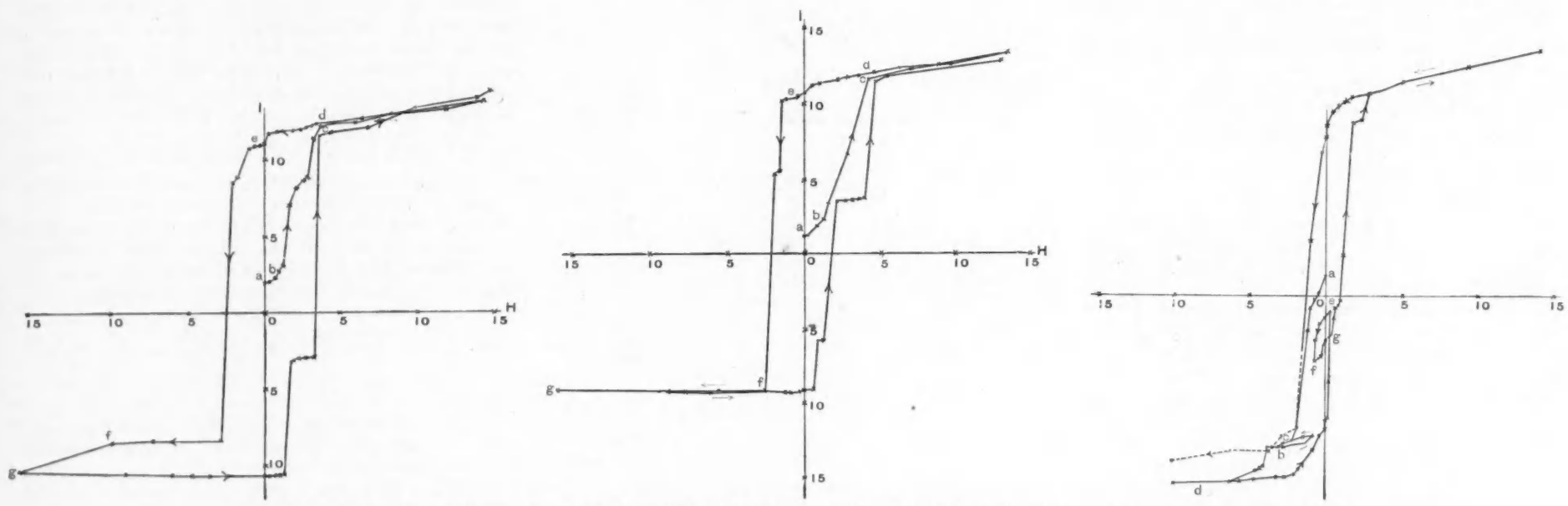


Fig. 3.—Direction of Magnets Corresponding to the Curve in Fig. 1.



FIGS. 1, 2 AND 5.—CURVES OBTAINED FROM A MODEL ILLUSTRATING EWING'S THEORY OF MAGNETISM.

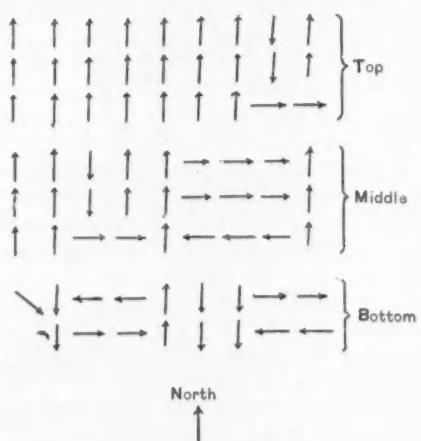


Fig. 4.—Direction of Magnets Corresponding to the Curve in Fig. 2.

These curves may possibly represent one group of molecules in a steel bar. Since the mean density of steel is nearly the same as that of iron, it appears that the large hysteresis of the former is due to the molecules in individual groups being nearer, the groups themselves being further apart than in soft iron. To diminish the hysteresis of the model, the magnets must be placed further apart in order to lessen the stability of their positions. The area of the curve can thus be decreased indefinitely. The curve of Fig. 5 was taken with the magnet centres 2½ inches apart—that is, with the magnet ends ½ inch apart at the closest. In this curve the cycle was performed in the opposite direction to that of the others. The last downward branch is dotted to distinguish it from the first. The area of the curve suggests at once that if Figs. 1 and 2 represent the case of steel, Fig. 5 represents soft iron—that is, the case in which there is a less intimate connection of the molecules in their respective groups.

At *b* a small cycle* was superposed upon the main cycle, as shown by the small loop. At *c* the loop returns to the main curve. If one of these minor cycles be performed at a point like *d*, which represents a stable position of the magnets, the curve merely retraces itself, illustrating the fact that there is no hyteresis without passing through a position of instability. On the contrary, at a point like *e*, where nearly half of the magnets have just turned, the area is very large. It is interesting to note that the curve took a new track at *g* instead of returning to *e*.

These are a few of the curves which have already been obtained from the model. They are necessarily very imperfect, largely on account of the relatively small number of magnets used. They suffice to show, however, the close resemblance of the model to actual magnetic metal, as far as the most important properties are concerned, which was all that was originally expected.

The Brooklyn Edison Plant Exhibition.

The Edison Electric Illuminating Company, of Brooklyn, N. Y., gave an exhibition of its handsome plant on Pearl street last week. The station of the above company is one of the model electric light plants of the country, the five floors of the immense building being arranged in a most convenient manner. On the first floor are the steam and electrical apparatus for the Edison three-wire system, and on the upper floors are the offices, meter-room, laboratory and shop. This station has been in successful operation for about a year and a half, and it was proposed to give to the people of Brooklyn an insight to what was being done in electrical illumination.

The building was handsomely prepared for the guests, and many interesting exhibits were on all sides. Lights, motors, meters, pumps, hoists, blowers, etc., etc., were in operation. Mr. Thomas A. Edison attended the exhibition. Over the door was the name "Edison," the letters being formed by lamps of high candle power, and a small motor kept automatically turning on and off the colored lights which were hung in festoons from the eaves of the building. The large assembly was extremely anxious to have a glimpse of the noted inventor, and Mr. Edison, with his usual geniality, gratified his admirers. Altogether, the exhibition was a most successful one, and no doubt the people of Brooklyn will have a greater interest in electric illumination than ever before.

An Auxiliary Fire Alarm.

Much delay is caused in many cases of fire by the necessity of having to procure a key and go frequently considerable distances to the local alarm box. It often happens, too, that the box door is inaccessible at a time when every moment's delay is serious. The Instantaneous Fire Alarm Company, of Buffalo, N. Y., has sought to overcome these defects in the municipal fire alarm system, and the auxiliary alarm telegraph of this company bids fair to come into universal use. The principle of the latter system is to send an alarm from individual houses by means of an auxiliary apparatus to be placed on the property of the subscribers.

This auxiliary alarm is within a small box, four inches by six, to be placed, one or more, according to the extent of the premises sought to be protected, in the residences, stores, school-houses, manufactories, public buildings, etc., of the city, each auxiliary box being connected with the

* Lord Rayleigh, *Philosophical Magazine*, March, 1887.

street fire-box nearest the place of its installation, which can be instantly "pulled" from the building. The successful working of the street box sends back to the auxiliary box a buzzing sound, which at once informs the sender that the alarm has been given. This system has been in successful operation in many parts of the United States for about two years.

The Electric Lighting of Saint Brieux.*

Electric lighting is slowly but surely gaining ground, and the towns which at first seemed least suited to its development now enter freely into the movement adopting this mode of illumination, appealing, in order to solve the fresh problems which present themselves in each particular case, to the most improved methods and the most elegant solutions now known in electrical industry, an industry of great richness and fertility, notwithstanding its youth. The lighting of the town of Saint Brieux supplied us with a typical example, and we think it will be interesting to give a general description of it; for we see in this instance, for the first time in combination, the utilization of a waterfall, the transport of energy to a great distance, the automatic compounding, and the coupling in parallel of the alternators by means of a reactive coil. As we proceed with our examination, we shall be able to see why this special method has been adopted, it being one which is suited to all the requirements of this particular case.

As it was possible to utilize, without great expense, a waterfall that had already been turned to account for a paper manufactory, which had been destroyed by fire, the employment of alternating currents of high tension with transformers was necessary. The distance of this waterfall, which is situated at Ponts-Neufs, at about 13 kilometres from Saint Brieux, is sufficiently great to entail a loss along the line amounting, at full charge, to 20 per cent. of the total power, in order to realize a saving by the establishment of this line. This loss, which at first seems considerable, is justified by the fact that the available motive force is amply sufficient to provide for all requirements at all seasons. At the time of the year when the water is low the days are longer and the duration of the lighting shorter, and the pond supplying the waterfall contains sufficient water in reserve to insure the working of the lighting system. The quantity of water supplied by the little tributary streams is always sufficient to make up for the lowering of level produced during the few hours that the system works during the dry season.

The fall at the Ponts-Neufs is about 11 metres. It works two vertical turbines of the "Hercules" type, constructed by Messrs. Singrun Brothers, of Epinal. The total power of these two turbines exceeds 300 h. p. They turn at a normal angular speed of 250 revolutions per minute, which speed is controlled by a centrifugal force regulator acting on the sluice gates until the speed becomes normal again, and thus the quantity of water brought to the turbine is regulated according to the power to be produced.

These turbines drive two Thomson alternators of 35 ampères. the electromotive force of which varies, according to the charge of the line, between 2,100 and 2,600 volts, with a view to maintaining at the extremity of the line, at Saint Brieux, an effective difference of potential of about 2,100 volts.

Each alternating current dynamo turns at the normal angular speed of 1,050 revolutions per minute, and bears 14 inductive poles and 14 inductive coils, thus corresponding to a frequency of 70 periods per second. The mode of excitation of these dynamos is worthy of special mention. The inductors are furnished with two distinct windings, the action of which is united.

The first winding is actuated by a special continuous current shunt dynamo, which serves as an exciter. Each alternator has its dynamo and special exciter, but one single exciter is sufficient, in case of need, to excite both the alternators. The excitation of the alternator is so regulated that with an open circuit it produces exactly 2,100 volts at its normal speed, by acting upon two rheostats introduced, the first into the excitation in a shunt circuit of the exciter, the second into the circuit of excitation itself.

The second winding of the alternator is fed by the principal current of the line. For this purpose the circuit of the 14 armatures is cut in the middle by a current redresser consisting of two rings forming a commutator, each provided with seven teeth on which two brushes rub, these being placed accordingly, and communicating with the second excitation winding of the alternator. It is easy to see that the alternating current is thus redressed and passes through the inductors in such a manner as to increase the excitation by a quantity in proportion to the principal current supplied along the line. The winding of the inductors is calculated so that the compounding thus obtained should be greater than is required. It is reduced to the proper value by mounting a shunt in derivation on the brushes of the exciter. The diagram accompanying this article shows clearly the principle of the arrangements we have described.

In short, then, for each dynamo there are eight wires leading to the centre of distribution; two for the rheostat of excitation of the exciter, two for the rheostat coming from the exciter introduced into the circuit of excitation of the alternator, two for the rheostat shunting the excitation by redressed currents, and lastly, two from the collecting brushes bringing the alternating current to the centre of distribution.

The distributing station contains, in addition to apparatus for regulating and controlling the excitation, which apparatus we have shown in their theoretical place in our diagram in order to simplify it, all the apparatus necessary for the introduction into the circuit of either alternator, for controlling the coincidence of its phases, for the parallel coupling, for the protection of the line and the station, for the testing of the state of insulation of the line, and, lastly, for the indication of the currents and the differences of potential.

We see by the diagram that the principal wires of each alternator arrive at a double interrupter after having passed through fusible circuit-breakers. The object of this double interrupter is to insulate completely from the station the machine which is not in use. At the terminals of the alternators is mounted the phase indicator, consisting of two little transformers, the primaries of which are coupled in derivation on the terminals of each alternator; the secondaries are coupled together in tension, and two lamps of 100

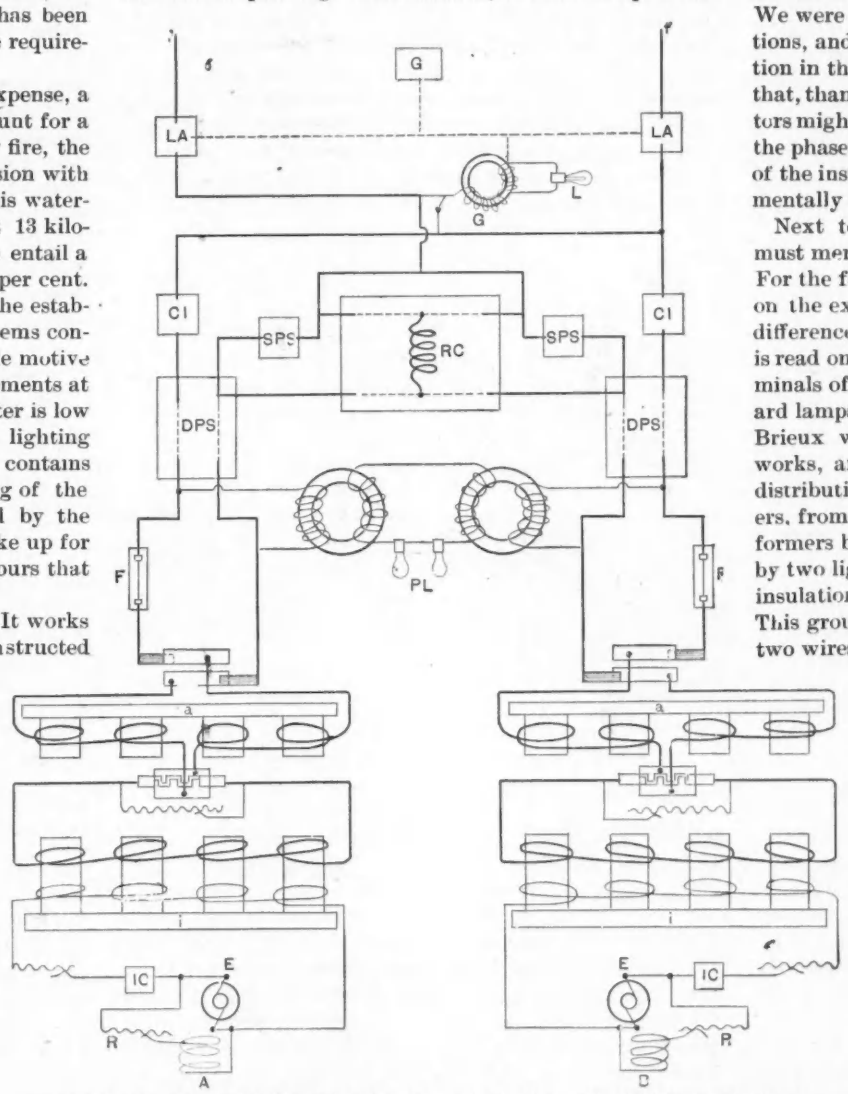


DIAGRAM OF CONNECTIONS AT THE ST. BRIEUX STATION.

f, feeder; G, earth; G_1, earth detector; R C, reactive coil; L, lamp: P L, pilot lamps; F fuse; *a*, armature; *i*, inductors; A B. alternators; E, exciter; R, shunt rheostat; L A, lightning arrester; C I, current indicator; S P S, single pole switch; D P S, double pole switch.

volts are introduced into these circuits. The connections are so arranged that the electromotive forces are united when the alternators are in the same phase. The lamps then burn with their full brilliancy. They are extinguished when the phases are contrary, for the electromotive forces induced in the secondaries are then in opposition.

In order to place an alternator on the line, it is necessary to close the corresponding double interrupter, and also the single interrupter. We will suppose that machine *A* being in circuit, it is required to connect the alternator *B* in parallel with the dynamo *A*. We begin by closing the double interrupter belonging to *B*, which has the effect of putting the two extreme wires of the two alternators into direct communication. (See diagram.)

We then observe the phase indicator, and when the phases coincide we turn the commutator of the *reactive coil* to the right, *i. e.*, toward the machine which we wish to bring into the circuit. This effects the coupling of the alternator *B* in derivation on the alternator *A*; but when the reactive coil is introduced into the circuit of the alternator *B*, this coil, having great inductance, greatly impedes the passage of the current, and this coupling makes no appreciable change in the load of the alternator *B*, which, notwithstanding the coupling, produced only a very feeble current. The inductance of the reactive coil is diminished by the displacement of the induced circuit, which gradually covers the inductive circuit and diminishes its resistance to the passage of the current (impedance) in consequence of the well-known reaction due to the increasing mutual induction of the two circuits. When the movable induced bobbin of the reactive coil has reached the end of its course, and entirely covers the inductive bobbin, it suppresses the reactive coil of the circuit by short-circuiting it. During the displacement of the induced bobbin of the reactive coil the load is gradually distributed, and is divided equally between the two machines, so that at the end of the manipulation, if the two alternators are well regulated as to speed and excitation, half of the total current is furnished by each alternator. The two alternators are then in parallel, and we have only to close the single interrupter of the alternator, *B*, in order to render the communication permanent and free the reactive coil, which should only be in the circuit at the moment of the coupling, and the induced circuit of which should be brought back into the position giving the maximum of resistance (impedance). When one of the alternators is in the circuit, and we wish to remove it, all we have to do is to open the corresponding double key. The load which was being distributed between the two machines is instantly directed into one only, and, as the two alternators are driven by a common axle, the transfer is effected without a break or change of speed.

The reactive coil is, therefore, useless for the purpose of uncoupling, but it is of the greatest service at the moment of coupling, for it substitutes a progressive action for a sudden one, and enables us to obtain from alternators what we obtain from continuous current dynamos connected in parallel by a simple variation in the excitation. We were present at several coupling and uncoupling operations, and saw that they did not produce the slightest variation in the brilliancy of the standard lamps. We even think that, thanks to the reactive coil, the coupling of the alternators might be effected without insuring the concordance of the phases, but owing to the prudence of the staff in charge of the installation we had no opportunity of testing experimentally the correctness of this opinion.

Next to the regulating and coupling apparatus, we must mention the controlling and the safety apparatus. For the former purpose, current indicators are established on the exciters and on the circuit of each alternator. The difference of potential at the terminals of each alternator is read on an indicator mounted in derivation on the terminals of the phase indicator, which also feeds two standard lamps. The difference of potential available at Saint Brieux will be indicated by a voltmeter placed at the works, and communicating by two return wires with the distributing box placed at the other extremity of the feeders, from which the mains supplying the various transformers branch out. The distributing station is protected by two lightning arresters, *L*, *A*, of the Thomson type. The insulation of the line is indicated by a ground detector, G_1. This ground detector is merely a little transformer with two wires in series, the thick wire being shunted through a lamp. The end of the thick wire is connected to earth; that of the fine wire may be placed by means of a commutator on one of the mains. If the insulation is good the lamp should remain dark, and it should burn with more or less brilliancy according as one of the two mains is in more or less perfect communication with the earth. If the right main is connected to earth, the lamp will burn when the ground detector communicates with the left main.

The line is wholly overhead, and supported by wooden posts with insulators consisting of double porcelain cups. The feeders are of Mouchel copper, and are each composed of a strand of 16 wires, the total section of which is 50 square millimetres. The resistance of this line is such that the loss at the full charge of 70 ampères will be about 500 volts or 35 kilowatts. We have already justified this loss, which is apparently excessive, by the peculiar conditions of the installation. We have said that the line is entirely overhead, but we must except a length of about 50 metres, which crosses a railway line. The company would not give permission for an overhead wire, so it was necessary to employ a Berthoud-Borel concentric cable, passing under the railway in a cast-iron pipe.

At the extremity of the feeders the line branches ou into three sections along which are arranged the transformers, at present 14 in number, and all of the 4,500-watts type. They reduce the potential of 2,100 volts which is supplied to them to 104 volts. Each of these transformers constitutes in itself a sort of little individual central station, the circuit of which supplies a varying number of consumers, but there is no connection between the secondaries of the various transformers. The transformers are provided with lightning protectors and circuit breakers on the primaries and secondaries, but no special precaution has been taken to guard against the possibility of an accidental contact between the primary and the secondary, with a view to the protection of the consumer.

A telephone line of course connects the works at the Ponts-Neufs with the offices of the company charged with the lighting of the town.

To small consumers the electrical energy is sold at so much per lamp per annum, according to the duration of the lighting, which lasts, according to the contracts, up to 8 o'clock in the evening (*sic*), 10 o'clock, midnight, or the whole night, the good faith of the consumers alone serving up to now as a guarantee that the lamps will be extinguished at the hour stipulated. The more important consumers will be charged according to the meter.

These are the principal points in connection with the

*From *The Electrical Review*, London.

electric lighting at Saint Brieux, the first installation established in France by the Thomson-Houston company by means of their double-excitation alternators and transformers. The installation is well arranged, and it is evident that there is no want of room. All the controlling, regulating and coupling apparatus are well within sight and reach, and the station is easily accessible from the back, which facilitates the superintendence and maintenance of the different parts.

The lighting of the town is undertaken by a local company, bearing the name of *Société d'Energie Electrique de Saint Brieux*, under the direction of M. Didier-Gagon, M. Bonfante being the engineer in charge.

The technical success of the undertaking is complete, and does the greatest honor to the company and to the Thomson-Houston company. We wish the company an equal financial success, for it seemed to us in our very rapid visit that the inhabitants of Saint Brieux left much to be desired as large consumers of light by night. Old habits have to be changed, and electricity will help in no slight degree—we will hope so at all events—to bring about these changes, on which depends is so large a measure the future of central stations supplying small towns.

Electrical Installations in Nashville, Tenn.

Among the Southern cities which have adopted electricity for various uses, perhaps none is in advance of Nashville. Its city electrician is Mr. F. W. Fairfield, and all of the various installations are made according to specified rules, drawn up for the guidance of contractors and constructors. At the present time there are in the city three electric street railway companies, operating in all about 50 miles of road, equipped with 60 electric cars. The Nashville telephone company has nearly 1,500 subscribers. The Western Union and Postal Telegraph companies have combined and some 55 telegraph wires enter the city from various directions. An electric light company operating two central stations furnishes 3,825 incandescent, 300 city and 100 commercial arc lights, besides operating a power circuit. An electric time company operates not far from 600 clocks.

As will be seen by the accompanying table, taken from municipal records, the city electrician has a very complete and detailed knowledge of the installation of the various electrical organizations of Nashville. The record is certainly a very creditable one and one that must prove of value to the operating companies themselves as well as to the city authorities, whose duty it is to legislate upon matters that relate to the municipal oversight of electrical organizations and to protect the property of the companies owning and operating under city franchises.

Considerable expansion in various lines is contemplated for the coming year. All of the electric railway companies are about to make additional equipment and enlarge their systems, necessitating in some instances new power plants and car sheds. The following table gives a very complete list of the electrical companies now operating in the city, together with the number of poles and miles of wire erected and owned by the various companies.

Name of companies.	Color adopted for poles.	Poles erected	Wire strung.	Miles.	Present business.
Cumberland Telephone and Telegraph Company.	Dark red	723	6¼ m. cables	430	1,500 subscribers.
			Iron	1,725	15 territorial lines.
Capitol Electric Company	Green top, black base	2,787	Simplex	100	300 city arc, 3,825 incandescent.
			Grimshaw	30	
			Std. underground	10	100 com. arc, 38 h. p. motors.
United Electric Railway Company	Dark green	2,316	Trolley	40	60 cars, 40 miles road in corporation; 60 in all.
			Feeder	15	T.-H., Sprague and Westinghouse.
Citizens' Rapid Transit Company.	" "	53	Trolley	2	3 cars, Sprague.
			Feeder	2	2 miles road in corporation; 4 miles in all.
Nashville Electric Railway and Power Company.	" "	248	Trolley	3	Under construction.
			Feeder	⅔	Rae system to be used.
Western Union Telegraph Company.	White top, black base	170	Main lines, iron	100	50 wires entering city.
			District, clocks, etc., insulated iron.	5	136 call-boxes, 6 electric clocks.
Postal Telegraph Cable Company.	Gray	133	Main lines, copper	8	4 wires entering city.
			District, insulated copper.	5	103 district call-boxes.
Nashville Electric Time Company			Insulated copper and iron	5	600 electric clocks.
City and private wires			Fire alarm, copper	5	65 fire-alarm boxes.
			" " iron	30	
			Private wires	3	Private telegraph, calls, etc.
Total		6,430		2,518⅔	

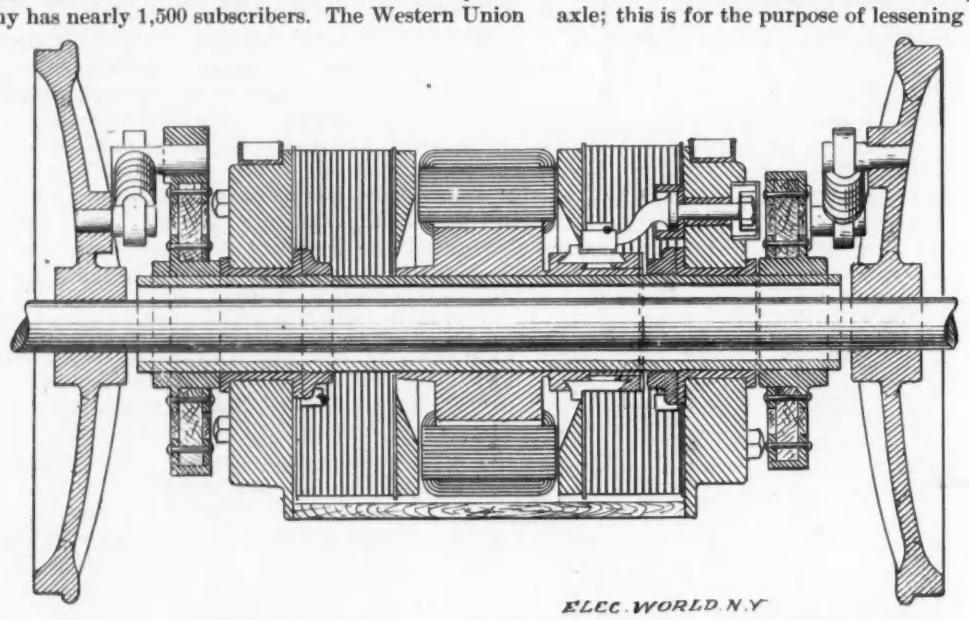
The Short Gearless Motor.

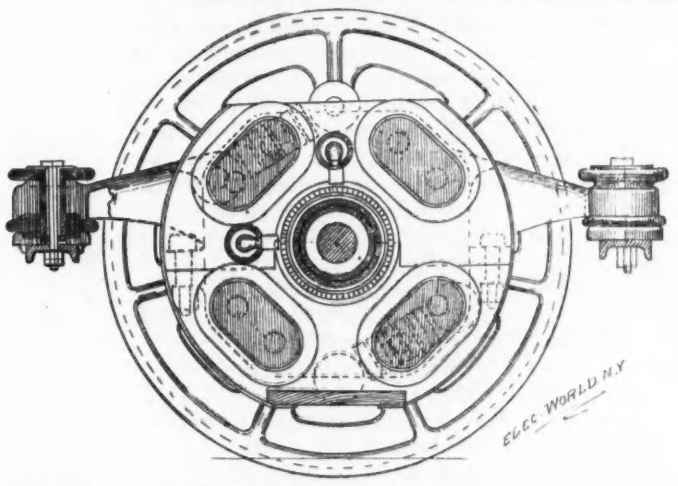
The accompanying cuts will give our readers a better idea of the Short gearless motor than could be derived from the early descriptions of it. Persistent experiments looking toward the present motor have been carried on for nearly a year, and for several months such a machine has been operated on various lines in Cleveland, and subjected to every test that the ingenuity of the inventors has been able to devise for the purpose of protecting any weak points that might show themselves. The result of this examination has been on the whole very satisfactory, so that the Short company now feels secure in pushing its work to the greatest possible extent.

A glance will show the general character of the machine. The armature has the form already familiar in the standard Short motors, namely, a flat Gramme ring wound with a very large number of independent sections. The diameter is as great as is consistent with getting the motor under the car, giving, of course, a powerful torque to compensate for the lack of gearing, and also a high back electromotive force to secure as much efficiency as possible at low rotative speed. The field magnets are of the regular Brush type, but eight in number, producing a four-pole machine with a very intense field and very narrow air gaps. The motor itself is not geared to the car axle, nor does it touch it at any point. It is flexibly supported at both ends, a construction which is rendered possible by the shape of the field magnets, inasmuch as a considerable vertical motion can take place without difficulty. The armature, of course, is centred upon the axle; as we noted in a previous description of the machine, it is not placed directly upon it, but upon a hollow shaft that allows a certain amount of rotation independent of the car axle; this is for the purpose of lessening the violence of a sudden rush of current when starting the motor from rest. The first movement of the armature is cushioned, as shown in the cuts, by a pair of springs, one acting in tension and the other in compression, and the full torque of the armature comes upon the axle only after a rotation of nearly 60 degrees. This feature of a semi-flexible connection between armature and axle is unquestionably good, as it lessens the wear and tear on the armature very considerably.

Owing to the large diameter of the armature a 36-inch car wheel is recommended for use with this motor, and under these circumstances there is a clearance of five and a half inches between the lowest part of the motor and the track, ample to allow for contingencies that are likely to arise. No thorough efficiency tests of the new motor have yet been made, but sufficient has been ascertained to show that it is decidedly ahead of the old forms of motors in commercial efficiency. Whatever efficiency may be lost in winding for slow speed is more than made up for by the immense gain of dispensing with the waste of power always incident to gearings. A glance at the cuts will show the great compactness of the new motor, and the arrangement of details. The regulation is accomplished by the ordinary method used by the Short company.

The trials in Cleveland have shown the machine to be thoroughly solid and reliable; it has even been subjected to the severe test of reversing at full speed without injury to the armature or producing any result more serious than a violent spinning of the wheels in the wrong direction. It has been run in all sorts of weather and under all manner of unfavorable conditions, and has, on the whole, shown itself fully up to the expectations of its designers. Altogether, it is a very interesting addition to the list of street-car motors. The 15 h. p. machine very closely resembles the 20 h. p. illustrated, except that it has only two poles and four field magnets, arranged as in the ordinary Brush dynamos; otherwise the construction is the same as that of the larger machine.





FIGS. 1 AND 2.—THE SHORT GEARLESS STREET CAR MOTOR, SHOWING THE DETAILS OF CONSTRUCTION.

The Properties and the Production of Aluminium.*

BY PROF. F. B. CROCKER.

There are two points in connection with aluminium which I wish to consider particularly. The first relates to the properties and the second to the production of aluminium. I think that Mr. Brown spoke very truly in regard to the exaggerated ideas of the advantages of aluminium, but I do not think he went quite far enough. The popular idea of aluminium is that all the good properties of all its alloys are attributed to aluminium itself. It is like one individual having all the good qualities of all his relatives attributed to him personally. This is, of course, an absurd fallacy. Nevertheless, it is one that is made in every newspaper article on the subject, and I am sorry to say it is frequently made in technical journals. The most common mistake of the kind is to attribute to aluminium itself the tensile strength of aluminium bronze, which exceeds that of wrought iron, and is about as high as good specimens of steel. It is really one of the most tenacious metals known, but its composition is about nine parts of copper to one part of aluminium; yet its tensile strength is almost invariably attributed to pure aluminium, having a specific gravity of 2.6, which is only one-third that of iron. They take the low specific gravity of pure aluminium and the high tensile strength of aluminium bronze. As a matter of fact, the specific gravity of aluminium bronze is higher than that of iron. Therefore we do not have lightness combined with high tensile strength. Turning again to aluminium itself, its tensile strength is about 26,000 pounds per square inch; in other words, about one-third that of iron. This just balances the difference in specific gravity, but still leaves the advantage in favor of iron, because one-third of the volume has the same strength and the same weight as a rod of aluminium. Now the same exaggeration is applied to its other qualifications; for example, its chemical properties. Aluminium bronze is remarkably free from tarnishing. A bright surface of aluminium bronze may be exposed to the atmosphere for several months and retain its polish. That property is attributed to aluminium itself. Aluminium, as Mr. Brown said, is not particularly liable to corrosion, but if it is subjected to salt water or alkaline water, or even ordinary moist air, it does tarnish and oxidize rapidly. Salt water is quite hurtful to it. Therefore, freedom from oxidation is another property that is wrongly attributed to it; and the objection to all this is that it gives a very wrong impression in regard to what would otherwise be a good and a legitimate object to admiration. I am not prejudiced against the metal aluminium, and would be very glad to see it used extensively, but I do not think its extensive use will be hastened—in fact I feel quite sure it will be retarded—by absurd exaggerations of its good qualities, because when people do come to use it they will be greatly disappointed. This common idea, for example, that it has 100,000 pounds tensile strength per square inch, and about one-third the specific gravity of iron, would lead any one to serious difficulties. Taking the general public, ninety-nine persons out of every hundred have entirely wrong ideas respecting it. There are certain things that seem to have a glamour about them—a word which Mr. Brown uses and which expresses the fact perfectly. Storage batteries and aluminium seem to be particularly favored by the public, and it has occurred to me that a combination of aluminium and storage battery—

*Presented at the opening of the discussion on Mr. Alexander S. Brown's paper on "Electricity in the Production of Aluminium" before the American Institute of Electrical Engineers.

that is an aluminium storage battery—would be simply irresistible. This sensationalism is really, I think, a bad thing for a new enterprise, because it is only destined to severe disappointment; but aluminium really has excellent qualities and can live down this gross exaggeration of them.

Now, taking *seriatim* the actual properties of the metal, and considering them as mechanical, chemical and electrical, we have under the mechanical head a specific gravity of about 2.6, which is almost exactly one-third of iron, and its tensile strength is 27,800 pounds, according to Mr. Brown, which is again almost exactly one-third of ordinary wrought iron. Therefore, iron and aluminium have equal strength, weight for weight, but iron has, as I have said, the great advantage of one-third of the bulk for the same strength and weight. Furthermore, any metal which "can be easily cut with a knife," is not particularly good for structural purposes as a metal. In my opinion it is too soft altogether. It is very much such a metal as zinc or tin. In fact, one can hardly tell the difference except by the weight, in filing or cutting it; and certainly tin and zinc are seldom used for structural purposes, and I do not think they would be, even if they were very much lighter than they are.

Taking up the chemical properties—I have already alluded to the ease of oxidizing, which, as I say, is not excessive, but still about equal to other metals, such as tin, zinc and iron. It is easily, in fact, eagerly attacked by acids. It is not much affected by sulphur or sulphuretted hydrogen, which is a great advantage. It is very freely dissolved by alkalies, whereas most other common metals are not. In an ordinary alkaline solution, aluminium is dissolved, as most metals are, in acids, with the evolution of hydrogen. This is quite a serious disadvantage for a common metal, which is liable, for example, to have soap used upon it. We do not expect metals to be attacked by alkalies.

As to the electrical properties, of course conductivity is about the only one. The electrical conductivity is about twice that of copper of equal weight, and is about half that of copper for equal volume. Where it is important to have a light wire, and the size is not to be considered, you can use an aluminium wire, because you get an advantage of 2 to 1 in weight. But when you consider size, for instance, a wire which has to be covered with insulating material that is expensive, then you would have a disadvantage. The figures happen to be very simple in all these cases.

In regard to the manufacture of the metal, that, I think, is an electrical monopoly, for the simple reason that I do not think anything else can successfully compete with electricity in the production of a metal the chemical affinities of which are as high as those of aluminium. Aluminium has great chemical affinities, ranking about half way between the ordinary metals and metals like sodium and potassium. These chemical affinities exhibit themselves when it is attempted to separate aluminium from chlorine or oxygen, for example. The ordinary smelting process does not seem to have ever been successful in the reduction of aluminium. So far as I know, aluminium has never been successfully reduced as iron or other ordinary metals are reduced by merely smelting in a furnace with coal. The nearest approach to this is smelting in presence of carbon, but with a very high temperature obtained by the electric current, higher than can be obtained by smelting. Therefore, even if we employ the process of smelting we still have to employ electricity. In any electrolytic reduction of the metal, of course, we have to employ electricity. Such a process seems to be a very simple and effective method, *i. e.*, the plain electrolysis of some compound of aluminium, the electrolyte being in a fused state between two electrodes. Now, the fused state is necessary instead of the ordinary aqueous solution, because if you attempt to separate aluminium in an aqueous solution you will get hydrogen instead of aluminium. In other words, water is more easily decomposable than the aluminium compound.

Thus we have the electrolytic process as a very successful process, and the fused state as apparently necessary, and not really objectionable, because the temperature of the bath may be kept up by the electrolytic current itself.

Then we have, as the only other likely substitute for these two electrical processes, the ordinary chemical method of reducing, by means of metallic sodium, some compound such as the chloride or double chloride of aluminium and sodium. But even then I think we had better make our sodium by electricity; so it would still be an electrical process. So far as I can see, and experience in the past few years seems to corroborate this view, electricity is the only commercial means of producing aluminium at the present price. In the old days, when the chemical process was used, aluminium was $12 or $15 a pound. Now it is about $1, and I doubt if any chemical process could compete on this basis. Therefore the reduction of aluminium seems to belong to electrical science, and it is certainly a very interesting and important application of electricity, and is, I think, destined to be perfectly successful. The purity of the metal does a great deal, as Mr. Brown says, toward improving its quality. It does make a very much better metal of it. The impure aluminium is really a poor metal in almost every respect except mere lightness. But empty space is much lighter than aluminium. So there is no particular object in paying a dollar a pound to fill up space with something that is merely light if it has no other desirable qualities.

The Electrical Transmission and Conversion of Energy for Mining Operations.*

BY H. WARD LEONARD.

The transmission and conversion of energy is, above all others, the question of importance in every kind of engineering work, and in mining engineering this is most conspicuously true.

Until quite recently all practical methods of transmitting and converting energy involved the actual transfer of sensible matter over the distance in question, and this matter necessarily possessed such qualities as weight, magnitude, temperature, inertia, and other qualities common to all matter.

It is, therefore, not surprising that all engineers, and particularly mining engineers, are watching with the keenest interest the development of methods for transmitting and converting energy by means of electricity; for, in electrical problems, the many considerations and restrictions due to the inflexible characteristics of matter may be entirely disregarded and the possibilities of mining engineering are correspondingly increased.

Perhaps the greatest stumbling-block has been the percussion drill. Until recently, when a mine owner asked if we could transmit his power, light his mine and operate his pumps, hoists, tramways and mills, we could confidently reply, "Yes." But when he asked if we could replace or operate his air drills we were obliged to say, "Not yet."

Since the drill is the most universal of all mine appliances operated by power other than hand power, it was not possible to make rapid progress until this deficiency was corrected, which has now been done.

In pushing engineering work, it is frequently of paramount importance that the work be done quickly. Therefore, any means of greatly increasing the rate of drilling is extremely valuable. To increase the rate of drilling we must either increase the strength of each blow or else we must increase the number of blows per minute. A limit to the rate of striking is soon reached when a valve of considerable weight must be moved from rest by the concussion of the previous blow, and when a material substance, such as air or steam, must then fill the space back of the piston and raise the pressure to the working pressure. Also the strains and shocks caused by the valve and the air or steam soon become troublesome as we increase the rate of striking. With the electric drill the speed of rotation of a perfectly balanced cylindrical armature of small diameter has no such limitations, and there is apparently no limit to the rate of striking, except the magnetizing and demagnetizing of iron, which is already done in daily commercial practice at the rate of 10,000 times per minute.

With 800 blows per minute we have already drilled at the rate of four inches per minute 1¼ inches in diameter in the hardest Quincy granite and that with an expenditure of energy not exceeding three h. p.

I firmly believe that in a comparatively short time we will be furnishing percussion drills whose rate of striking will be several times as much as that we now employ, and that, with no more and no heavier drills than are now used, the rate of driving a heading will be increased many times. The importance of rapid driving of work is practically illustrated by the fact that in driving the Sutro Tunnel, Mr. Sutro offered the men at work, in addition to their regular wages, the following bonus:

For every foot per month over 300 and under 400	$5
For every foot per month over 400 and under 500	10
For every foot per month over 500	20

A bulletin from the Census Department under date of March of this year shows that in granite quarrying the cost of labor is 64 per cent. of the total cost of production, and in Massachusetts, where the output is much greater than in any other State, and where the longest experience and most approved methods are met with, the labor is 82 per cent. of the total cost. It will be evident that any labor-saving device in such a field will be extremely valuable.

Another drill of great value to the mining engineer is the diamond drill.

Up to the present time diamond drills are operated by reciprocating engines, and the engine is fastened upon the same frame as the drill-rod, to which it is geared by suitable gearing. The engine usually has two cylinders of the oscillating type, to reduce the vibration as much as possible and eliminate the dead points. With those small engines it is practically impossible to automatically get the close regulation of speed which is desirable, and hence the speed is governed entirely by hand throttling, and the engines cannot be run at very high speed, because of the vibration they would produce and because of the rapid depreciation of such engines at high speed. It, therefore, becomes necessary to gear to the drill-rod by gearing which is oftentimes objectionably large, and would be even larger if a higher speed upon the drill-rod were used. The space occupied by the drilling machine is quite large, owing to the size of the engine, gears, etc. This is a great objection in cases of operation in tunnels, shafts, etc.

With the electric drill the motion is free from any jar, as there are no reciprocating parts and the speed can be made absolutely constant under any condition of load up to the full load. It can also be made anything desired, up to several thousand revolutions per minute, and under any conditions of speed above 1,600 per minute there would be no gears whatever. The weight of the electric diamond drill is, for the same power, much less than that of the steam diamond drill, and the space occupied is in a direct line with the hole and is extremely small in amount.

The electrical transmission and conversion of energy at great distances is destined to come up in nearly every mining problem in the future. Mines are usually in a mountainous country, and it is seldom that a water power cannot be found within a few miles of a mine. The mining engineer in the immediate future will develop this water power, convert its energy into electric energy, in which shape he will transmit it to the distant mine, when it will be again converted into the various forms of energy which he may have occasion to require.

Among the applications will be the following:

1. The lighting of the mines and the buildings and grounds by arc and incandescent lamps.
2. The operation of any machinery in the mill, such as crushers, stamps, and so forth.
3. The operation of the drills.
4. The operation of the hoists.
5. The operation of the pumps.
6. The operation of an electric tramway in the mine.
7. The operation of ventilating fans.
8. The heating of the building when fuel is scarce.
9. The refining of copper, and recovery of gold and silver in certain cases.
10. The concentration of magnetic ores in certain cases, such as iron, nickel, and so forth.

In order to give you a commercial idea of a plant such as is likely to be used in mining operation in the immediate future, I will suppose a case, and give you an estimate of the first cost and operating expenses of such a plant. Let us suppose that we have a mine where we have to operate the following devices:

Three hundred and sixty incandescent lamps of 16 c. p. each.

Ten arc lights.

One hoist requiring 30 h. p.

One pump requiring 20 h. p.

Six percussion drills for drilling 1½ inch holes at the rate of three inches per minute.

Two rotary diamond drills, 1¼ hole, ¾ core, rate two inche per minute.

One mine locomotive, 10 h. p.

Milling machinery requiring 30 h. p.

Heating requiring 10 h. p.

The total power required for the above will be 180 h. p. delivered from the main motors. Suppose that at a distance of three miles there is a good water power which can be developed and equipped with water wheels to produce 300 h. p. by an expenditure of $16,000.

In order to secure the 160 h. p. necessary at our various devices in and about the mine, we must deliver 200 h. p. to our main motor in the form of electric energy in the conductor at the brushes of the motor. With 25 per cent. loss in conductors this will mean 266 h. p. at the generator brushes, or 300 h. p. delivered by the water wheels.

For the sake of reliability and economy we will use two generators instead of one, each being 133 h. p. At the mine there will be two main motors of 90 h. p. each, wound for 900 volts and 83 ampères, producing a total of 180 h. p., which will drive the drill generator of 17 h. p. and a generator of 250 volts and 300 ampères for operating the incandescent lamps, the arc lamps, the locomotive, the hoist, the pump, the diamond drills and for heating. The main motors will also supply the milling machinery with the necessary 30 h. p.

An estimate of cost of such a plant for transmitting 130 h. p. a distance of three miles with a loss of 25 per cent. in generators gives the following result:

Developing original water power and installing water wheels of 300 h. p.	$15,000
2 generators, 100 K.W. each (1,200 volts—83 ampères each)	7,200
2 motors, 75 K. W. each (850 volts—83 ampères)	5,400
Copper, 32,000 feet	4,000
1 6-drill generator	2,000
1 generator, of 250 volts, 300 ampères, 75 K.W.	2,700
6 electric percussion drills	3,300
2 electric diamond drills	1,100
360 incandescent lamps and appliances	360
10 arc lamps	220
1 30 K.W. hoist	2,255
1 20 K.W. pump	1,595
1 10 K. W. locomotive	1,815
Heaters, 10 K. W	600
Conductors for all secondary transmissions	1,000
Labor of installation	3,000
Poles	455
Freight, cartage and sundry expenses	1,000
Total	$53,000

The operating expenses of such a plant will be those mainly due to the wages of the men for each shift, one at the water power and one at the mine.

A fair allowance for depreciation and repairs will be five per cent. per annum of the first cost.

The operating expenses will, therefore, be about as follows:

	Per annum.
One first operator	$900
One second operator	600
Depreciation and repairs, five per cent on $53,000	2,650
Sundry incidental expenses	250
	$4,400

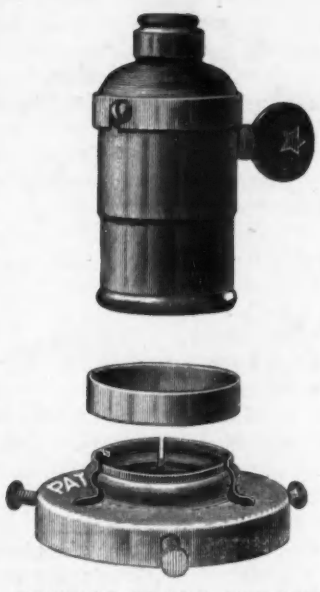
The production of the same power by steam, when coal is $2 per ton, and labor such that an engineer's wages are $2

*Abstract of a paper read before the Association of Mining Engineers of the Province of Quebec.

per day, would be not less than double this amount; and in many instances where water and fuel suitable for the generation of steam are difficult to obtain, such a plant would represent a saving of its entire first cost every year.

The Remhof Shade Holder.

The accompanying illustration shows the Remhof ring-locking shade holder for incandescent lamps, manufactured by Mr. A. Remhof, 375 Kent avenue, Brooklyn. In fastening the shade to the socket no screws whatever are used,



REMHOF SHADE HOLDER.

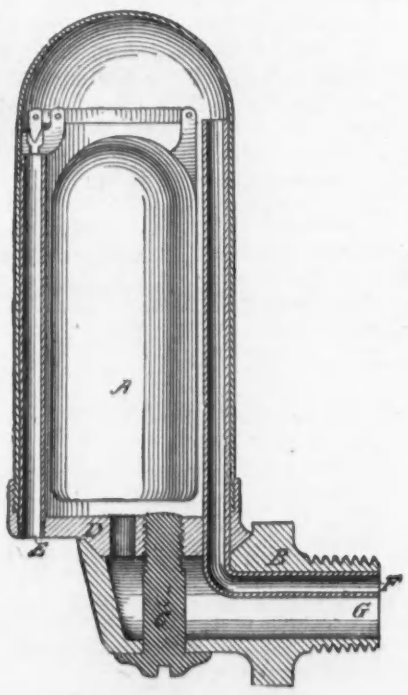
so that it is very easily adjusted. The method of securing it in place will be readily understood from the illustration, and it will be seen that any one can apply it easily and quickly. It is made to fit both standard and special size sockets, and for all varieties of incandescent lamps.

Van Auken's Hot Water Automatic Air Valve.

Rapid advancement in the past few years has been made in automatic devices for the control of steam as a heating medium, but very little has been done for the regulation of hot water heating by automatic means. Automatic air valves of every kind have been invented, but until recent date a reliable and perfect working automatic air valve for hot water heating has been unknown.

The Van Auken Steam Specialty Company, of Chicago, has placed a valve on the market which is entirely automatic in its action. The valve is shown in the accompanying illustration.

It is claimed for this device that it will keep the radiator free from air at all times, and will positively prevent the escape of water. The principle of the working of the valve is the same as that of the piping of a hot-water plant, as by means of a small tube which opens from the radiator into the upper portion of the valve a constant circulation is kept through it at all times. This allows the hot water to rise to the top and the cold to escape through the lower opening into the radiator. The valve being placed at the

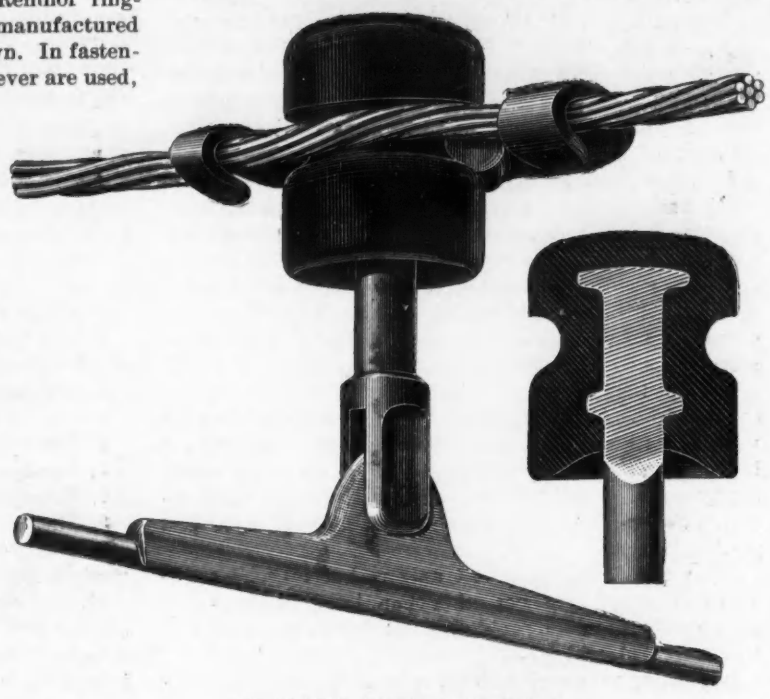


HOT WATER AIR VALVE.

highest point on the radiator, of course the air accumulates in it, and as it does so forces the water out of the valve into the radiator. When the valve becomes full of air the float drops and allows the air to escape until the water again enters and closes it, thus acting automatically. The valve does its work well and reliably, requiring a minimum adjustment and attention. It is made in two parts, so that it can be kept close to the radiator.

A New Trolley Wire Insulator.

A new form of trolley wire insulator, which has just been put upon the market by Emmet Bros. & Griswold, of 150 Broadway, New York city, is shown in the accompanying illustration. It is known to the trade as the "Cinch" insulator. The insulating material is of rubber, similar to that ordinarily used for combs. The stem and



TROLLEY WIRE HANGER.

yoke of the insulator are of malleable iron and the pin is made of brass. Whatever strains are brought upon the insulator are entirely those of compression. It will be noticed that there are no screw threads either upon the pin or the insulating material. The objects aimed at by the designers of this insulator are great strength, high insulating properties and small size, combined with durability and low cost.

A New Connector for Street Car Lighting Circuits.

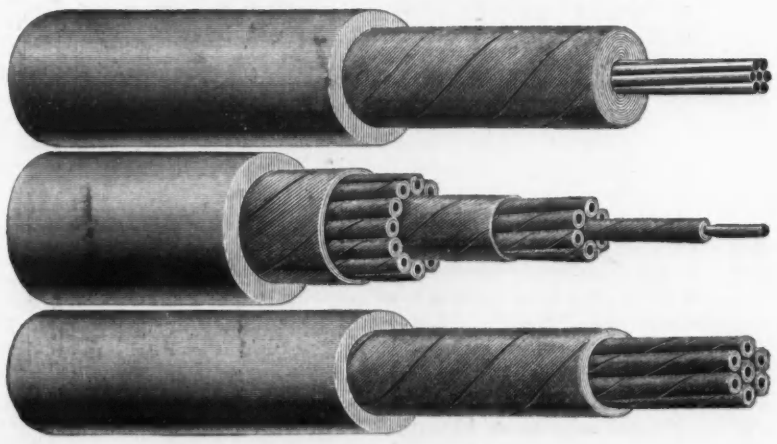
The accompanying illustration shows the new form of connector for the lighting circuits of motor and tow cars

CONNECTOR FOR STREET CAR LIGHTING CIRCUITS.

on electric railways, designed by Mr. Chas. G. Armstrong, of Chicago, which has some good features. It is placed upon the market by Geo. Cutter, of Chicago. The two parts are interchangeable, and the projecting metal tips are in circuit only when the two parts are slipped together. When the parts are separated these ends are dead and may be handled with safety, even in wet weather. The end of each conducting cord is soldered into a brass tube, and a knot in the cord takes all the strain off this joint. The contact surfaces are large, and a stiff spring insures a quick make and break. The insulating bushings, as well as the shell, are made of hard rubber nicely finished. The connector is not much larger than the illustration, and is well made throughout.

A New Material for Cable Insulation.

The enormous advance which has been made in the practical applications of electricity to a great variety of

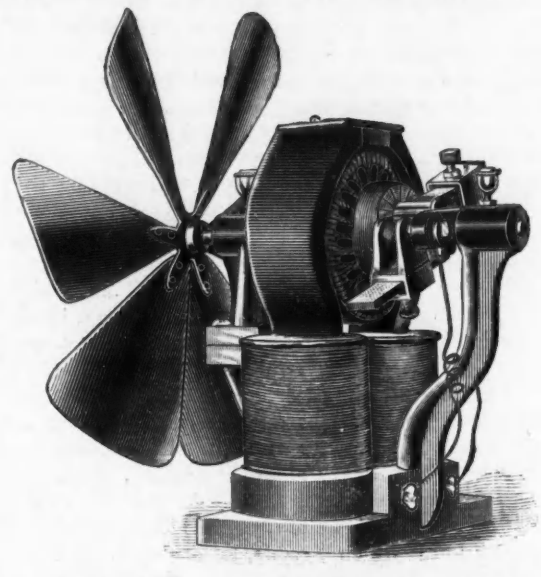


PAPER INSULATED CABLES.

purposes has called forth the exercise of a great deal of ingenuity to provide a cheap and efficient insulation for electrical conductors. One of the newest materials for this purpose is the paper insulation of the Norwich Insulated Wire Company, illustrations of which are given on this page. The wire is insulated with strips of the strongest manila paper, wound on in overlapping spirals. The paper is expressly made for the company, and arrives at the works in rolls containing a web from half a mile to five miles in length, and weighing from 20 to 90 pounds per ream. These rolls are cut into strips about half an inch wide and perhaps a mile long.

After the wires are covered they are compounded with a material called "Sydite." They are then braided, and again treated with a modification of the same compound, and are polished and reeled ready for the market.

When wire is insulated by this process the conductor must necessarily remain, no matter how roughly it is treated, absolutely central. Paper being one of the most incompressible of materials, and it being applied to the



THE FORD & WASHBURN FAN MOTOR.

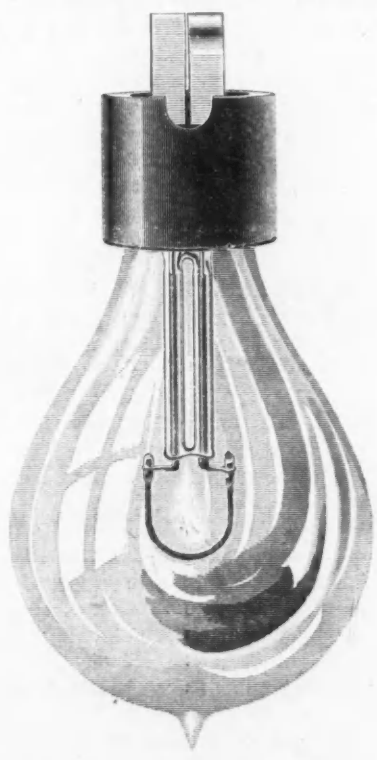
wire spirally under die pressure on each strip as it is put on, the result is perfectly cylindrical and uniform insulation. It is, therefore, very easily run through solid cleats of the exact size required, and avoids the necessity for using double or split cleats, which often arises from insulated wire being of irregular diameter.

The Ford & Washburn Fan Motor.

Among the few serviceable fan motors placed upon the market this season is the Ford & Washburn, which is shown in the illustration on this page. Simple in construction, strongly built, having but few parts, all of which are interchangeable, the motor will practically take care of itself. The fan blades are placed at the proper angle to secure the best results. The motor is manufactured by the Ford & Washburn Electric Company, of Cleveland, O.

The Buckeye Lamp and Its Manufacture.

To secure a lamp that would prove more efficient and economical than any now in the market has been the aim of the Buckeye Electric Company, of Cleveland, since its organization, and, after having discarded several processes that resulted in the production of lamps of average efficiency and



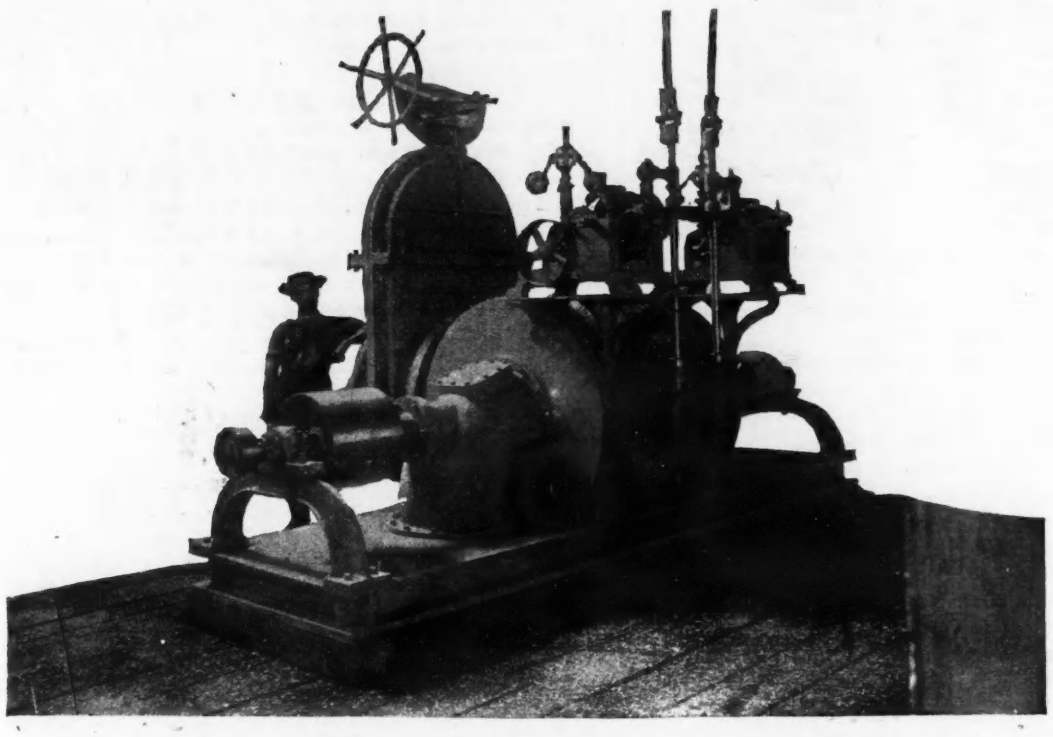
BUCKEYE SERIES LAMP.

life, the company secured the American patents covering the production and treatment of a filament that has shown remarkable results under a series of severe, extended and expensive experiments, conscientiously carried out with the view of discovering its actual commercial value. And so well is the company satisfied with the filament that it is now offering to the consumer a lamp which is considered to be of very superior quality.

Every detail in the manufacture of this lamp has been carefully worked out, and from the moment the process commences till the bulb is packed away for shipment it passes through no less than 20 hands or different departments.

The factory is located at 1,925 to 1,931 Broadway, the offices being established down town in the Arcade, and with the present equipment 500 lamps can be turned out daily. But additional ground has been purchased, and it is the intention to have the capacity of the factory doubled.

The dynamo room contains two Continental, one Kimball and two Excelsior dynamos, belted to line shafting, that is driven by a New York safety engine supplied with steam from Babcock & Wilcox boilers. Packard vacuum pumps are also belted to the shafting. Mr. Arnold Spiller, a well-known young chemist of London and Vienna, has entire charge of the laboratory and is acting as general superintendent of the factory, which is under the direct management of Mr. C. H. Rockwell, treasurer of the company. The Buckeye company is also supplying consumers with a series lamp, shown in the cut on the preceding page, having a short, dense, heavy filament for use on arc circuits of 4½ ampères to 10 ampères.



THE VICTOR TURBINE USED IN THE SPOKANE FALLS LIGHTING STATION.

A Victor Turbine Operating an Electric Light Plant.

The accompanying illustration shows a pair of 10-inch Victor turbines on a horizontal shaft complete, with flume bed-plate, governors, etc., as designed and built by the Stilwell & Bierce Manufacturing Company, of Dayton, O., for the Edison Electric Illuminating Company, of Spokane Falls, Wash. The wheels were designed for special service. This pair of turbines operates under a head of 70 feet, developing 186 h. p., and arranged for driving two dynamos direct from the turbine shaft. The feeder is provided with a valve gate for shutting out water. Each turbine is entirely independent, being provided with a separate gate apparatus and governor, so that either one or both can be operated, as desired. While this pair of wheels was designed expressly for driving the two dynamos, it will readily be seen that similar designs can be adapted to a very great variety of work.

The Howard Dynamo.

The accompanying cut represents the Howard dynamo, manufactured by Hiram M. Howard & Co., Cincinnati, Ohio. The field magnet has a single magnetic circuit of very low resistance, due to the material used and the proportions of the various parts. Only one coil is used to magnetize the field. The core is built up of charcoal sheet-iron. Each pole-piece is a single casting of charcoal iron, and is very massive, having a sufficient cross-section to give that part of the magnetic circuit the same conductivity as the core. The coil is compound, having both a shunt and series circuit.

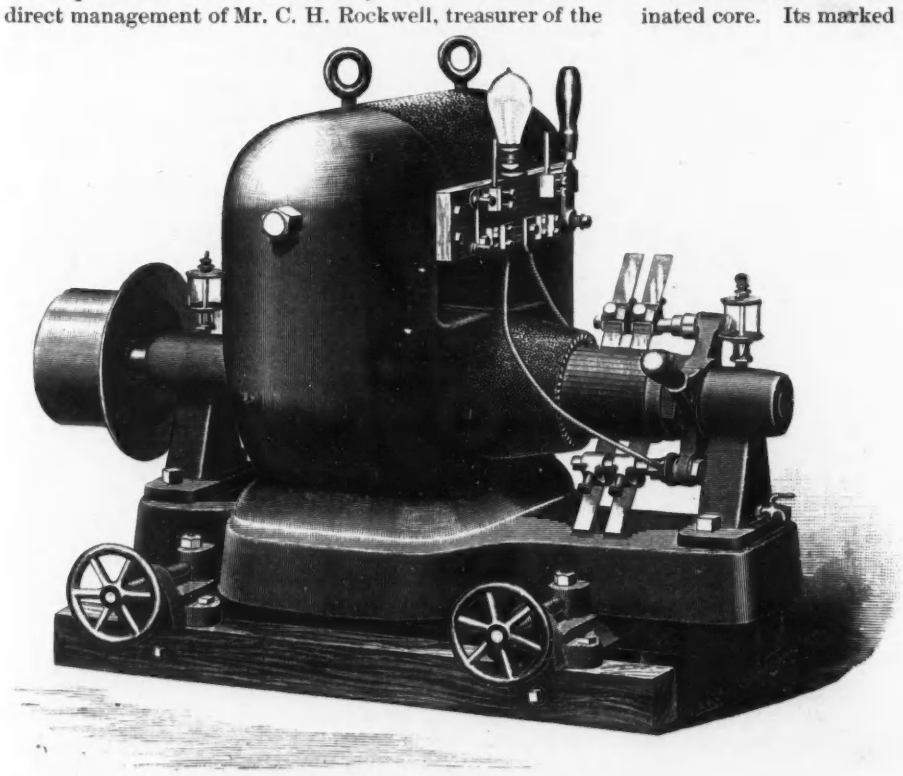
The armature is of the drum type, having the usual laminated core. Its marked peculiarity is in the method of winding, which is done with a flat or ribbon-like conductor, wound in such a manner that a sufficient number of turns having a large area of cross-section can be put on the armature core, still maintaining a short distance between the core and the faces of the pole-pieces.

In the 300-light machine the armature has 80 turns in the conductor, the resistance of which is 0.02 of an ohm. The series coil of the field has a resistance of 0.008 of an ohm, and the shunt coil has 19 ohms.

These machines are at present built in twelve sizes, ranging from 10 to 500 light capacity, and are also wound for motors from ¼ to 35 h. p. The motors are wound for 110, 220 and 500 volt circuits.

A number of these dynamos have lately been installed at various points in Ohio, Kentucky and Indiana, and their operation is highly satisfactory.

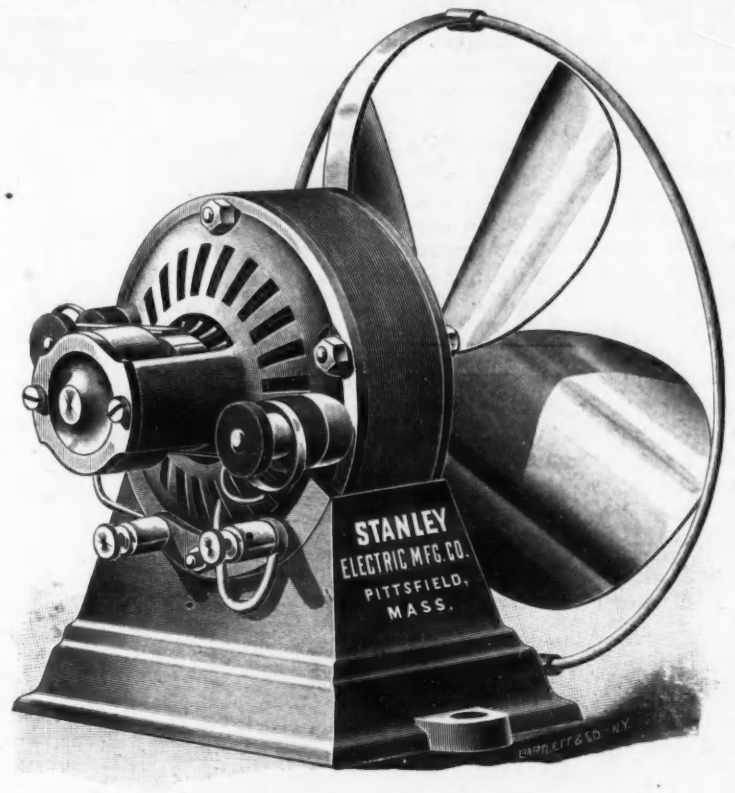
The motors constructed by the company have also been put into service in various parts of the West, and have proved to be well constructed and admirably fitted for their work.



THE HOWARD DYNAMO AND MOTOR.

The Stanley Alternating Fan Motor.

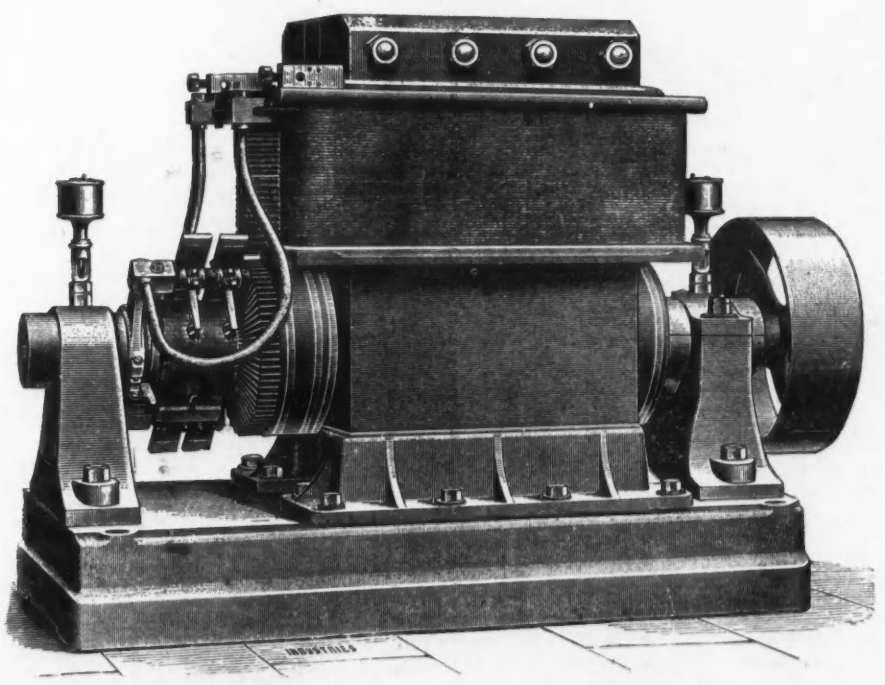
In the design of a fan motor, shown in the accompanying illustration, Mr. William Stanley, Jr., has aimed not only to overcome the technical difficulties which have heretofore existed in the construction of a small alternating current motor, but has endeavored to construct an essentially portable apparatus. The motor which has been constructed and is now placed upon the market might be called a desk motor, as it is well adapted for placing about on desks, tables, etc. As will be seen from the illustration, the design of the motor is very compact, and though so very small in its dimensions, it is, at the same time, thoroughly constructed, both mechanically and electrically, in every detail.



THE STANLEY FAN MOTOR.

The total weight of the motor complete with fan and base is a little less than nine pounds. All the materials used are of the best, and the workmanship is first-class in every particular. The commutator is large, the shaft as heavy as is necessary and the brush holder permanent in its adjustment. The shaft is of steel, and the bearings are self-oiling.

It is claimed that only 1½ ampères are required to drive the motor on a 50-volt circuit. When running at a high speed, the motor is almost noiseless. The fan is 6½ inches in diameter, and the base of the motor occupies a space 3½ × 5¾ inches.



THE SIEMENS COMPOUND-WOUND DYNAMO.

The Siemens Compound-Wound Dynamo.*

The accompanying illustration shows the latest type of Siemens' compound-wound dynamo with drum armature. In this particular machine wrought-iron field magnets of a somewhat smaller cross section than those adopted by many makers have been used, and these have been wound with the series wire on one limb only. This makes the connections simpler, and produces practically the same re-

*Abstracted from *Industries*.

sult as if it were wound partly on each limb. The armature is built up of iron discs, and the conductors consist of strands compressed into rectangular bars, which are arranged round the outside of the armature in the usual way. The end connections are made by the Siemens method, and care has been taken to secure good ventilation. The underneath type of dynamo shown in the illustration has the advantage that massive brackets and framework are not required to secure steadiness of running, and it also relieves the bearings of the great pressure to which they are subjected in dynamos where the armature is on the top, while in a properly constructed machine the proximity of the bedplate to the magnetic poles does not injuriously affect the efficiency. By varying the supports of the armature and magnets, this design of dynamo can be readily adapted for coupling direct to any type of steam engine.

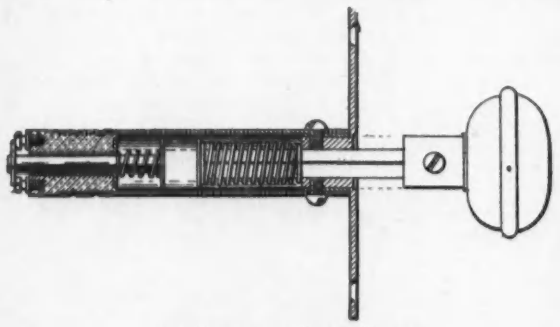
Dynamos of this construction have been supplied by Messrs. Siemens for the St. James and Pall Mall Electric Light Station at Mason's Yard, the Whitehall Station of the Metropolitan Electric Supply Company, the Westminster Electric Supply Corporation, the central station of the Bradford Corporation, the Liverpool Electric Supply Company, and many others for public and private installations. At the Royal Naval Exhibition they will shortly have running for illumination of the buildings and grounds, in addition to an alternator and some smaller machines, three shunt-wound dynamos of this description coupled direct to Willans engines, each capable of working up to 1,500 ampères at a pressure of 120 volts. The armature is 24 inches in diameter, and runs at a speed of 350 revolutions per minute within a magnet with very massive limbs.

A Steamer Connected with the Telephone Exchange.

Mr. R. H. Browne, of Fort Smith, Ark., deserves credit for arranging a system of connections by means of which the steamer "John Matthews," which has a telephone installation on board, is placed in connection with the central exchange whenever it comes into port. A telephone is placed in the captain's office, and the wire connecting with it is carried to a flexible cord, fitted with a connector at the side of the boat. The wire leading from the exchange is brought down to a corresponding position on the dock, and is also fitted with a connector. Whenever the ship comes into port it is only necessary to make the connection, and it is at once ready for the purser to communicate with any one of the business houses in Fort Smith, or with any of the numerous towns connected with the telephone exchange through long-distance wires.

An Electric Door Pull.

In the accompanying illustration is shown what is known as the "Eastern Electric" door bell pull, which is placed upon the market by the Eastern Electric Supply and Construction Company, of Boston, Mass. When the pull is drawn out, as shown in the illustration, to ring the bell, the metal spindle, which is



An Electric Door Pull.

beyond, but in alignment with the pull spindle, is forced inward by the spiral spring about it, fixed between its headed end and the hard rubber piece shown on the left, which is fastened by any suitable means in the outer end of the cylinder or sleeve, leaving a portion of it beyond the cylinder. This movement of the spindle brings its metallic head in contact with the binding post and completes the electric circuit between the lead wires. When the connection is made the spindle is completely insulated.

The Adrian (Mich.) Local Telegraph Company.

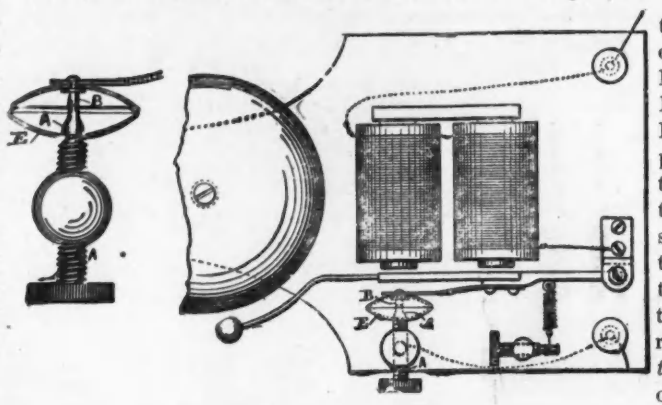
In a recent number of The Electrical World, attention was directed to an organization of local telegraphers at Richmond, Ind. Our attention has just been called to a similar organization at Adrian, Mich., of which Mr. C. M. Sickels is the manager, the objects of the company being very much the same as those of the Richmond company.

Adrian is a city of about 10,000 inhabitants, and the local telegraph line, which is some five or six miles in length, reaches to all parts of the city. The printed call cards show a list of 25 subscribers. The membership fee is $1, and each member is required to furnish two cells of battery. The monthly dues are only ten cents, and each member furnishes his own instruments and keeps up his own section of the line.

Varley's Electric Contact Protector.

Much difficulty is frequently experienced in the electrical operation of call bells, in consequence of particles of dust or other foreign substances getting in between the contact points, and the risk of the alarm becoming inoperative is augmented by the fact that considerable periods of time often elapse during which the call is not in use.

To obviate this, Mr. Richard Varley, Jr., of Englewood, N. J., electrician at the works of the Okonite Company,



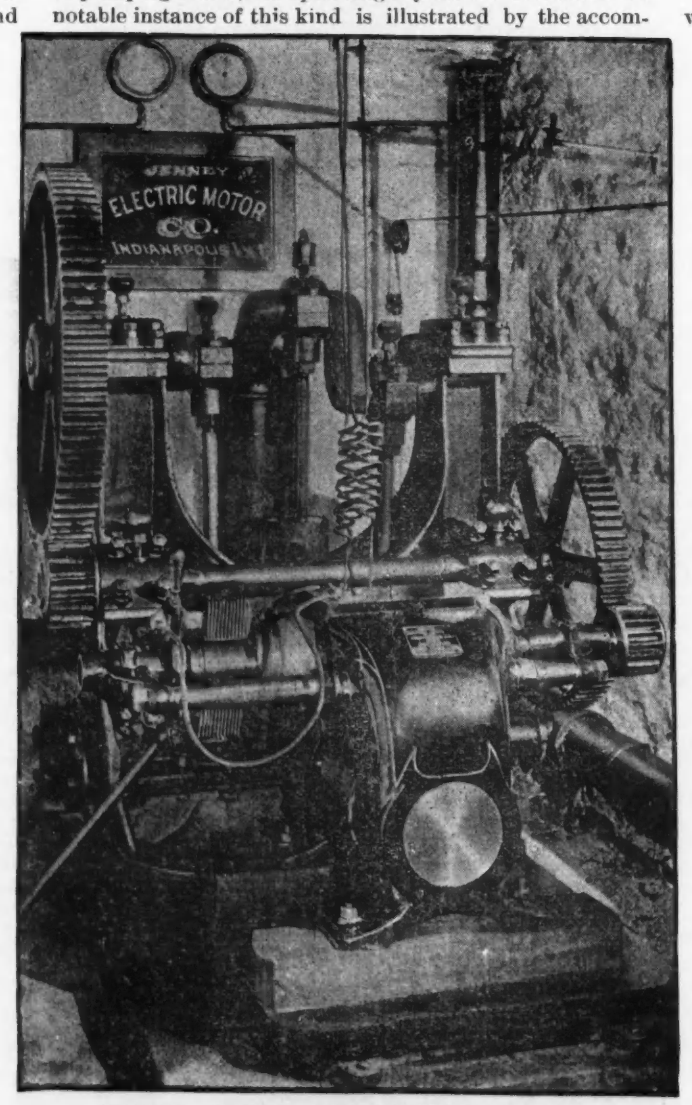
Varley's Contact Protector.

has invented the device shown in the accompanying illustration. As will be seen, the contact *A* is in the form of a screw with a platinum plug, and the other contact, *B*, is held by the spring attached to the armature.

This protector *E* is made of thin sheet rubber that extends from one contact to the other, forming a dust-proof inclosure. This protector is made of two discs with a central opening in each, one fitting around the button head of the contact *B* and the other around the end of the screw *A*. The discs are united at their edges and vulcanized, thus excluding all dust. Hence it is not necessary to inclose the bell or magnet in a case, as is sometimes done, to aid in keeping the bell in working order.

The Jenney Motor Applied to a Hydraulic Pump.

An interesting application of the electric motor is that of pumping water, for operating hydraulic elevators. A notable instance of this kind is illustrated by the accompanying cut. A 7½ h. p. Jenney motor is shown geared to a Goulds triplex pump at the Board of Trade Building, Indianapolis. City water had been used to operate the passenger elevator, but it was found that quite a saving in expense could be effected by sinking a well, putting in a motor and pump in the basement, and placing a tank on the roof.



JENNEY MOTOR AND HYDRAULIC PUMP.

The combination has been working successfully for several months, furnishing ample water for the passenger elevator as well as for use throughout the building. The motor requires very little attention, and is much more desirable than a steam plant for the same work, as there is no heat, dust or noise. It is started and stopped automatically by means of a special switch, which is operated by a float in the tank. The small pinions are of rawhide and the bearings on the motor are self-oiling. The operation of this plant has been satisfactory from the start, and is worthy of special notice on account of the very considerable saving in expense.

Frankfort Official Journal.

It is announced that by order of the board of directors of the international electrical exhibition in Frankfort, an official paper is to be published under the title of *Electricität*. It is to appear in weekly issues, and will be edited by Dr. Max Quarck and H. Massenbach, engineer, in Frankfort. It will be the mouthpiece for the official reports of all the particulars of the electro-technical exhibition. It is said that the journal will bring before its readers a history of the origin and course of the exhibition, a complete representation of the present state and prospects of electrotechnics, an authentic report of the work of the juries and the consultations of the professional congresses which are to meet during the exhibition, as well as carefully selected, reliable reports and discussions on the exhibits. The *Electricität, Officielle Ausstellungszeitung*, will also contain original papers, detailed reports and notices, and will be illustrated. It will be published weekly, and there will be altogether 30 issues.

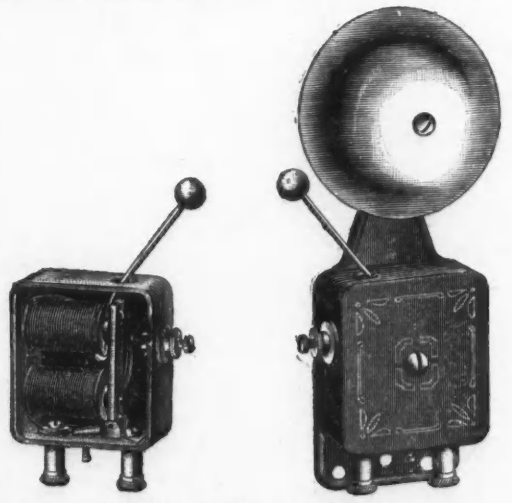
Platinum and Palladium Crystals.

Mr. Joly, of Trinity College, Dublin, says the London *Electrical Engineer*, gives the following method of obtaining crystals of platinum and palladium. A ribbon of the pure metal is stretched horizontally between two binding screws and dusted with powdered topaz. An electric current is then passed through the ribbon, which is thereby raised to a red heat. In about half an hour the current is stopped, and the ribbon examined by a microscope. Small brilliant crystals of the metal are seen to have formed on the topaz. If the heating be kept up longer, these crystals will grow to the size of a millimetre in length.

A New Iron Box Electric Bell.

In the accompanying illustrations is shown a new bell which has been placed upon the market by W. R. Ostrander & Co., of 195–197 Fulton street, New York City.

It will be noticed that the armature has bottom and side adjustments, and is pivoted in such a manner that, although it works very freely, it is impossible for the points to get out of contact. It can be adjusted to ring on one cell of battery. The contact points are made of platinum wire, riveted in, and the armature spring is phosphor bronze. The hammer rod is twisted in the armature so that it is impossible for it to work loose. The works are all in the box, which is held to



An Iron-Box Electric Bell.

the back plate by a centre screw. The back plate, when once on the wall, need never be taken down, as to get at the works it is only necessary to remove the box.

Electric Tanning.

A series of careful experiments has been carried out during the past winter on the Groth system of tanning, and a paper by Dr. Rideal and Mr. A. P. Trotter was read before the Society of Chemical Industry in London recently, in which full details of the work were given. It has been found that a very small current gives the best effect, about two ampères being employed in a vat holding 2,000 gallons and containing 30 hides. The tanning is completed in about 8 or 10 days instead of 8 or 10 months.

There is at present no satisfactory theoretical explanation of the manner in which the tanning is hastened, and it has been feared that the matter might rest under some suspicion. Indeed, when the works were visited last year by a number of chemical experts, they went away with very doubtful opinions as to the merits of the invention, or indeed, of the truth of the information which was given to them.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Edison Electric Illuminating Company, of Boston.—Application has been made to the Listing Committee of the Boston Stock Exchange to list the stock of the Edison Electric Illuminating Company, of Boston. The authorized capital stock of this company, says the Boston *News Bureau*, was recently increased from $1,310,000 to $2,000,000. At the same time the directors authorized the issue of $690,000 six per cent. convertible debenture gold bonds dated May 1, 1891, due May 1, 1901. These bonds may at the option of the holder be converted into stock at par. The subscriber was allowed to take either stock or bonds, but not both, so that the capital stock of the company will not reach the authorized issue—$2,000,000—until all the debenture bonds have been converted into stock. The last sale of the stock was last week at par ex three per cent. semi-annual dividend. The annual report published Feb. 3, 1891, shows gross earnings, $283,551; lamp royalties, $4,099; expenses, $175,338, leaving a net income for 1890 of $108,213, against $74,092 in 1889 and $16,705 in 1887. The lamps connected Dec. 31, 1890, were 39,986, against 25,000 the previous year and 8,380 in 1887. The motors connected Dec. 31, 1890, were 1,541 h. p. against 900 h. p. previous year and 300 h. p. in 1887; an increase during the year in lamps of about 60 per cent., and an increase during the year in motors of about 71 per cent. The balance sheet for the year ending Dec. 31, 1891, showed among the assets: License under Edison patents, $320,596; cash on hand, $25,516; stock supplies, $39,988; current accounts due the company, $66,672; plant valued at $1,140,029; and among the liabilities: Accounts payable, $78,369; notes payable, $171,500, and total liabilities of $1,605,697. The officers are: Jacob C. Rogers, president; Walter C. Baylies, vice-president, W. W. Gooch, clerk; Hubbard Breed, treasurer and assistant clerk. Directors: W. P. Mason, T. J. Coolidge, G. S. Silsbee, C. L. Edgar, C. H. Coster and F. S. Hastings. It is understood that there are now nearly 70,000 lamps of the Edison Electric Illuminating Company in use in Boston.

Phonograph Matters.—Mr. Jesse H. Lippincott, the president of the Phonograph Company, made an assignment during the week; his liabilities are placed at $500,000 and his assets at $400,000. He names preferred creditors to the amount of $25,000. The stock has been inclined to strengthen on account of the assignment, because it is the belief of investors that the phonograph business will fall into other hands and be improved. This is not intended as a reflection upon Mr. Lippincott, but simply means that the public is aware of the fact of Mr. Lippincott's poor health and his inability to give proper attention to the business. It is rather a serious thing for a stock to show the weakness that the phonograph stock has done in the last year. It has fallen from $75 per share to $5 a share with very little show of substantial rises after the drop.

Westinghouse stock still continues to be strong, and the list shows many transactions. The annual meeting of the Westinghouse Company was to have been held last Monday, but was postponed until May 18 on account of the negotiations under way for placing the preferred stock. The following resolution was adopted by the board of directors of the company:

"It is moved that in view of the fact that in the opinion of this board it is not advisable to announce at this time the details of the plan for placing the preferred stock of this company, liquidating its floating debt and securing working capital, which has been substantially completed, the stockholders be requested to adjourn the annual meeting called to-day to Monday, May 18, 1891, at 10 o'clock in the forenoon, Westinghouse Building, Pittsburgh, Pa. In the negotiations which have been so nearly concluded, the interests of the present stockholders have received special consideration, with a view of giving a permanent value to their stock. The business of the company has been continued without interruption, and, although with a lesser volume than for the same period last year, the net results have been better. The orders in hand and those being received are equal to the capacity of the works, and it is expected that the arrangements which have been made will soon put the works of the company in full operation. A large reduction in expenses has been effected, by reason of which and a more conservative business policy the affairs of the company have been steadily improving since the 1st of January."

It was stated last Saturday that a syndicate, consisting of August Belmont & Co., of New York; Lee, Higginson & Co., of Boston, and Brayton Ives, president of the Western National Bank, has been formed to undertake the reorganization of the Westinghouse Electric and Manufacturing Company and its associated interests. This syndicate, together with certain creditors of the company and others, has agreed to take $3,000,000 of 7 per cent. preferred stock upon the assent of the stockholders to the plan of reorganization. Messrs. August Belmont, Marcellus Hartley, Henry B. Hyde and Brayton Ives, of New York, and Charles Francis Adams and Charles Fairchild, of Boston, it was said, had consented to become directors. According to the plan the $10,000,000 capital is not to be increased. The holders of the $7,000,000 common stock outstanding are to surrender into the treasury 40 per cent. of their holdings, which with the $3,000,000 issued but not sold will make about $6,000,000 of treasury stock. Of this $4,000,000 is to be converted into 7 per cent. stock, of which the $3,000,000 specified above is to be issued to care for the floating debt and provide working capital, and $500,000 is to be held in the treasury to provide further capital when needed. A part of the remaining treasury stock is to be used to purchase further stock in the United States Electric Lighting Company and the Consolidated Electric Light Company, in both of which companies the Westinghouse company is already extensively interested. The rumor that the Edison and Thomson-Houston companies were among those who were to give financial aid to the Westinghouse company is undoubtedly incorrect.

The Erie Telephone Company.—The annual report of this company for the year ended Dec. 31, 1890, contains the following statement:

	1890.	1889.		
Gross	$1,383,668	$1,255,570	Inc.	$128,098
Expenses	1,045,038	957,305	Inc.	87,733
Net dividends	$338,630	$298,265	Inc.	$40,364
Dividends	298,265	270,726	Inc.	27,539
Surplus	$40,365	$27,539	Inc.	$12,8.6

The balance sheet shows as follows: Assets, licenses, $4,268,000; plant, $6,678,991.04; trustee stock, $231,000; stocks and bonds, $26,000; real estate, $16,271.50; construction (for the year 1890), $351,002,25; office furniture, teams and tools, $33,817.41, bells, material and supplies, $265,219.77; accounts receivable, $199,935.40; cash and deposits, $149,504.41; total, $12,219,741.78. Liabilities, capital stock, $10,394,600; surplus account, $373,675.72; bonded debt, $1,000,000; income account, $181,130.05; reserve account, $237,139.11; accounts payable, $33,196.90; total, $12,219,741.78. The number of subscribers Dec. 31, 1890, was 21,967, against 20,553 Dec. 31, 1889, an increase of 1,521. The expenditure upon plant and equipment was $765,153, against $654,438 in 1889. There was charged to new construction $351,002, of which $159,369 was expended for underground work. It is estimated that $750,000 will be expended for extension and maintenance in 1891.

Thomson-Houston.—A quarterly dividend of $1 per share has been declared on Thomson-Houston stock, payable May 16. The stock has not been very active during the week.

Western Union Telegraph.—Test office receipts for the past week show earnings of $250,300, an increase of $8,785 over the corresponding week of last year.

Fort Wayne Electric Stock has not been dealt in to any great extent recently, and yet a dividend of 75c. per share has been declared payable May 15.

Mexican Telephone Stock.—A dispatch from the City of Mexico says that the Mexican Telephone Company's contract has been approved without change by the city government to run 12 years. By the terms of concession the company erects iron posts in 53 streets of the city and where more than 16 wires are carried they must be made into a cable. Work commences three months from the time that the contract is approved. At least 20 poles must be changed every three months, and the work must be concluded by two years from the date of commencement. A new switchboard will be placed in the central office, and the company gives a guarantee of $1,000 that the terms of the contract will be carried out in the time specified. It only remains for the Governor of the federal district to approve the concession for it to go into effect.

New England Telephone.—The New England company is selling 500,000 six per cent. 15-year bonds at 102½, which makes a total funded indebtedness of $1,500,000. This is to be expended in extending underground operations.

Edison stock has been a little off during the week. The inactivity of the general stock market is the reason for it. F. Z. M.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, May 9, 1891, in New York, Boston and Washington were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	80¾	81
American Telegraph & Cable	100	14,000,000	....	82½
Central and South American	100	5,000,000	145	160
Mexican	100	2,000,000	205	220
Commercial Cable Co	100	7,716,000	105	108
Postal Telegraph Cable	100	5,000,000	39	41
Edison General Electric Co	100	9,503,500	99	100
" " Deferred	100	2,436,500	....	....
Consolidated Electric Light	100	1,929,400	....	....
Edison Electric Illuminating Co	100	2,567,800	76	78
United States Electric Light	100	1,500,000	30	31
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	*14½	45½
" " preferred	25	4,000,000	25¾	26
" " Series C	10	400,000	9	9¼
" " Series D	10	120,000	7	7¼
" International Co	100	1,000,000	....	....
Thomson Welding Co	100	1,000,000	....	....
" European Welding Co	100	1,000,000	55	60
Ft. Wayne Electric Co	25	4,000,000	*13¼	13½
Westinghouse Electric Mfg. Co	50	5,000,000	15¼	15½
Telephone:				
American Bell	100	12,500,000	....	206½
Erie	100	4,800,000	*48¾	49
New England	100	10,304,600	51¾	....
Mexican	10	1,280,000	....	....
Tropical American	10	400,000	....	60c.
MISCELLANEOUS.				
Edison Phonograph Doll	10	1,000,000	50c.	....
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	....
Chesapeake & Potomac	100	2,650,000	58	64
American Graphophone	10	600,000	5½	6½
United States Electric Light (Washington)	100	300,000	163½	172
Eckington and Soldiers' Home Electric Ry	50	352,000	48	50
Georgetown and Tennallytown	50	200,000	62¼	64

* Ex-dividend.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$230@$245	Cumberland	$60@ $62
Central Union	57@ 58	Wisconsin	118@ 120
Michigan	86@ 88	Bell of Missouri	160@ 165
Great Southern	30@ 32	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell.	40@ 43		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$105@$106	Chicago Edison Co	$145@$150

AFFAIRS OF THE COMPANIES.

The Abington & Rockland (Mass.) Electric Light Company held its annual meeting last week. Of the capital stock nearly $50,000 has been paid in.

The Gettysburg (Pa.) Electric Light, Heat and Power Company has been organized by J. H. Rowe, N. C. Freck, F. R. Gilbert, J. E. Weist, E. H. Leffler and others, and an application has been made for a charter.

The Southern New England Telephone Company has mortgaged to the Union Trust Company, of New Haven, property valued at $300,000. The company will use the money in extending its line and making improvements.

The Citizens' Electric Light Company, of Lansdowne, Pa., last week elected the following officers: President, James S. Austin: vice-president, Samuel L. Kent; directors, Edward V. Kane, James Garrett, John Fongar, H. C. Keyes, Dr. J. W. Phillips, John Adams and Thomas Burwell.

Mr. John Rychen is one of the directors of the Wyoming (O.) Light, Water, Heat and Power Company. Mr. Rychen was elected at the last annual meeting of the stockholders, instead of Mr. O. Reich, as mentioned some time ago. The above company has declared a dividend of four per cent on last year's business.

The Scott Electrical Manufacturing Company issued an announcement last week stating that the annual meeting would be held at the company's office, No. 1 Exchange place, Jersey City, N. J., on Wednesday, May 13, at 4 P. M., and that the principal business of the meeting would be the election of a board of directors for the coming year.

The People's Electric Light Company, of Flint, Mich., held its annual meeting last week, and the following officers were re-elected: President, J. J. Hurley, secretary, Arthur G. Bishop; treasurer, Romain Putnam. The directors elected were as follows: J. J. Hurley, Romain Putnam, Arthur G. Bishop, C. H. Conover, A. H. Gillies, Geo. E. Taylor, Geo. H. Turner, Flint P. Smith, Alex. McFarlan,

NEW INCORPORATIONS.

The Citizens' Street Railway Company, of Mattoon, Ill., has been incorporated to build a street railway. The capital stock is $50,000. The incorporators are George S. Richmond, L. B. Craig and E. P. Rose.

The Ottawa (Can.) Electric Street Railway Company has been organized with the following officers: President, J. W. McRae; vice-president, Geo. P. Brophy; treasurer, Wm. Scott; and secretary, D. C. Dewar.

The Carbondale (Ill.) Electric Company has been incorporated to construct and operate an electric light plant. The capital stock is $5,000. The incorporators are Rufus D. Bradberry, George W. Graham and W. A. Schwartz.

The West Penn Haven (Pa.) Telephone Company, with a capital of $25,000, has been chartered. The directors are W. H. Denniston, Samuel Hamilton, Charles Parker, W. C. Hamilton, Robert M. Hamilton and J. W. Kinnear, all of Pittsburg, Pa.

The Rogers Park (Ill.) Light, Heat and Power Company has been chartered to build and operate gas and electric plants. The capital stock is $75,000. The incorporators are Hervey E. Keeler, Newton A. Partridge and George W. Wilbar.

The Put-in-Bay (O.) Electric Company has been incorporated with a capital stock of $50,000. The incorporators are: George H. Ketchum, Noah H. Swayne, John H. Doyle, J. K. Tillotson and Frank M. Ohl. The principal work of the company will be an electric railway, although it will also include electric lights and other similar appliances.

The Miller Electric Danger Signal Company has been organized in Portland, Me., with a capital stock of $1,000,000. The officers are: President, William T. Ober; treasurer, Horace A. Roberts; clerk, Benjamin G. Ward. The directors are: W. T. Ober, H. A. Roberts, E. E. Hill, A. H. Whitten, S. S. Marsh, Mial W. Chase and G. E. Miller.

Baltimore, Md.—The Electro-Automatic Transit Company, of Baltimore, has sold its right, title and interest to the Weems Electric Railway System, a new company organized in New York to develop railroad transit by electricity. The Weems Electric Railway System has been organized with a capital of $2,500,000, divided into shares of $100 each. The officers are: O. J. Smith, president; David C. Weems, vice-president and general manager; Wayne B. Stowe, secretary; John W. Grant, treasurer; A. DeR. Sappington counsel. The general offices of the company are in New York. The engineering department still continues in Baltimore, with David C. Weems in charge.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, May 11, 1891.

The Interior Conduit and Insulation Company, of this city, it is announced, has purchased the business of C. C. Sibley & Co.

Mr. Curtis, of the Short Electric Railway Company, Cleveland, O., was a caller at this office last week. He reports the business of the company in a prosperous condition.

Mr. C. C. Sibley, who recently sold out the business of C. C. Sibley & Co. to the Interior Conduit and Insulation Company, is to take charge of the Universal Arc Lamp Company, at Nos. 42 and 44 Broad street, this city, as general manager of the company.

High Rates for Ambulance Calls.—The New York Hospital authorities refuse to pay $900 for subway service for wires for their ambulance calls, and trouble is anticipated. Other downtown hospitals, it is expected, will follow their example. This, however, applies only to the Fire Department calls.

The New York Insulated Wire Company, manufacturers of Grimshaw white-core wire, having found that the disposition of the trade was to buy direct from the manufacturers, has decided to make Chicago a distributing point, and to that end will at once open a large warehouse at 78, 80, 82 Franklin street, between Lake and Randolph streets. Mr. G. H. Meeker, well known to the trade as the active representative of this company throughout the country, will act as western manager with a full corps of clerks and assistants. Mr. Meeker extends a cordial invitation to all his friends to call about May 20.

The Franklin Experimental Club, of Newark, held its thirty-first regular meeting at the club laboratory, Tuesday evening, May 5. The president, Mr. Wm. J. Hammer, read an interesting paper entitled "The Arc Light." As illustrating the rapid development of this industry, the speaker instanced the fact that there was exhibited at the Centennial Exposition in Philadelphia in 1876 but a single arc system, the Wallace, while now arc lights are burning everywhere and are numbered by the thousand. Mr. Hammer summed up the problems confronting the arc light men, and called attention to the field for invention in alternate current lights. The paper was illustrated by diagrams prepared and mounted for the occasion. Mr. F. M. Crane spoke on electric railroads. He compared the three systems which are striving for supremacy in this field: the trolley, the storage, and the conduit. At the next meeting, May 19, Prof. Geo. C. Sonn will deliver a paper on the "Phenomena of Earthquakes," and will illustrate it with lantern slides. Mr. Earl Atkinson will speak on "Electric Motors." At the first meeting in June it is expected that Mr. Nikola Tesla will address the club. L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, May 9, 1891.

Lowell, Mass., has granted the street railway people the right to lay double tracks on nearly all their lines and to use electricity with the trolley system.

Middlebury, Vt., will hereafter be lighted by electricity, the Common Council having closed a contract for 30 arc lamps of 2,000 c. p., to be run on the moonlight schedule. The Thomson-Houston system will be used.

The Wright Engineering Company is at work putting in 1,500 feet of underground work in addition to 600 feet previously laid for 1,000 volt current at the residence of R. G. Dunn, Narragansett Pier. The company is also wiring the house for a 40-light incandescent plant.

Reorganization.—The firm of H. W. Leach & Co. has been reorganized and incorporated under the name of the Leach & Grant Company, to carry on general engineering and construction work. The officers are: H. L. Grant, president; H. W. Leach, treasurer, and H. E. Grant, general manager in charge of construction work,

The National Pipe Bending Company reports the placing of some large contracts for heaters as follows: 300 h. p. in Baltimore, Md.; 500 h. p. in Portland, Me.; 150 h. p. in Salem, N. H.; 300 h. p. in Salem, Mass.; 1,000 h. p. in New Bedford, Mass., and one 500 h. p. for export. Notwithstanding the large addition to the works the company is barely able to keep up with the orders.

The Thomson Scientific Club, of Lynn, Mass., held a well-attended and instructive meeting on Thursday of last week. A paper on "Electric Railway Reminiscences" was read by Mr. Blackwell, who has been actively interested in the construction of electric railways for a number of years. He gave many amusing anecdotes of the days when it was an exceptional armature that would resist for a whole week the temptation to "burn out." Mr. C. D. Haskins presented a review of some of the more recent geographical explorations in Central and South America. C. A. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY TRUST BUILDING, PHILADELPHIA, May 9, 1891.

Messrs. Strawbridge & Clothier have purchased two 40 arc-light Wood machines.

Mr. William Crompton, of the Economic Electric Manufacturing Company, of Boston, Mass., was in Philadelphia last week on business.

Mr. J. W. Parker, agent for the C. & C. motors in this city, has just returned from a three weeks' trip through the Southern and Middle States.

The Lehigh University Electrical Laboratory, at South Bethlehem, Pa., is to be built at once. The lecture-room will have a seating capacity of 500 students.

The Ries Electric Traction and Brake Company has working models of its specialties on exhibition at 315 Drexel Building, which are attracting considerable attention.

Mr. J. F. Clarkson, of Woodbridge, N. J., builder of the first Edison electric road, favored this office with a call last week. Mr Clarkson is on his way to visit the old battlefield at Gettysburg.

Williamsport, Pa.—The Lycoming Electric Company has closed a contract with the Fort Wayne Electric Company, through its agent, Mr. G. A. Wilbur, for a 240 arc-light plant of the new Wood system.

The Novelty Electric Company has accepted the agency for the "Economic" lamp, manufactured by the Economic Electric Manufacturing Company, of Boston, Mass. These lamps are having a remarkably good sale, over 35,000 being in actual use after six months' introduction.

The Fort Wayne Electric Company, through its Philadelphia agent, Mr. G. A. Wilbur, has closed a contract with the Manufacturers' Electric Company, of this city, for a 5,000-light plant of the Slattery incandescent system, and a 240-light plant of the new Wood arc system The Manufacturers' Company has that part of the city north of Montgomery avenue and east of Broad street embracing a territory of nearly 40 miles square. The latter company is building a handsome station of 1,000 h. p. capacity at Somerset and American streets, which, when finished, will be one of the finest plants in the city. W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, May 9, 1891.

Mr. H. M. Underwood, the general western agent of the Interior Conduit & Insulation Company, reports having secured the contracts for placing the interior conduit throughout the Fourteenth street pumping station in Chicago.

The Short Electric Railway Company has secured the services of Mr. R. C Garhart, well and favorably known as a former representative of the Westinghouse Electric Company. Mr. Garhart will represent the Short Company in general eastern territory for the present. F. DE L.

CLEVELAND, O., May 9, 1891.

Mr. John Henthorn, the well-known engineer of Providence, R. I., visited Cleveland this week.

Mr. J. Lester Woodbridge, of the Woodbridge & Turner Engineering Company, of New York city, stopped over a day in Cleveland this week.

Mr. P. G. Monroe, editor and publisher of the *Stationary Engineer*, of Chicago, Ill., stopped at the Hollenden House this week, en route to New York City.

The Fletcher & Fletcher Electric Company, of Cleveland, O., is taking good advantage of the new postal regulations permitting the mailing of 11-pound packages to Mexico. The company tells a neat story of a carriage manufacturer who took a light buggy to pieces and shipped it through the post-office.

CINCINNATI, May 9, 1891.

New Lexington, O., proposes to build an electric road to connect with Redfield, five miles distant, and another to Bristol, three miles distant.

Newport, Ky., is to have electric street lights. The Suburban Electric Light Company has been granted by council the privilege of erecting 108 arc lights, to cost the town $8.33 a lamp per month. The company is required to furnish a bond of $10,000.

The Thomson-Houston Company, of Cincinnati, is installing a new electric light plant at Lancaster, O., to take the place of the old plant there. The local company had about 70 lights. An all-night service with the same number of lights will be furnished now.

Cincinnati (O.) and Newport (Ky.) Railway.—The new electric railroad between Cincinnati and Newport has been granted the right of way over the streets of Cincinnati. The last span on the new Ohio River bridge, over which the cars are to run, will soon be completed.

Another Electric Railway.—It is proposed to build an electric road to Price Hill, a western suburb of Cincinnati, at a cost of $150,000. A legislative bill for the purpose has been prepared. It provides that the county shall bear half the expense of construction and the abutting property owners the other half.

The Citizens' Electric Light Company, of Covington, Ky., offers to contract with that city for a period of 25 years to furnish arc lights of 2,000 c. p. at the intersection of each street on Madison avenue at $10 per lamp, or they will furnish incandescent lamps of 16 c. p. at $20 per annum. The proposition has been very favorably received.

The Corcoran Subway Bill passed the Ohio Senate last week and is now a law after a hard fight of six weeks. It authorizes the construction of a subway in the streets of Ohio cities into which all electric wires may go. The city is to construct, operate or lease the subways, or a corporation to do so;—the owner, however, to permit all electric companies the use of the conduit, and the owner or lessee to pay a percentage of its gross annual revenues into the city treasury. It is provided, further, that all existing rights granted by the courts—such as the right of way granted by the Superior Court of Cincinnati and the Probate Court of Hamilton County—shall not be abrogated by this law.

Brush Injunctions.—The Circuit Court has rendered its opinion in the cases of the Brush Electric Light Company vs. the Jones Bros.' Company and the Queen City Electric Light Company. The Brush Company asked for an injunction preventing the other companies from placing their wires upon the poles erected by the plaintiff company. The court finds that when the ordinance (March 3, 1882) was passed giving the Brush Company authority to erect poles, and under which they were erected, the city authorities did not possess the power to grant the authority they sought to vest in the plaintiff; consequently the poles erected by the Brush Company were put up under a license or acquiescence on the part of the city authorities, and such poles are subjected to the later day provisions, which authorized electric light companies to use each other's poles on a proportionate payment of the costs.

The Edison General Electric Company, of this city, has cleared its tract of land on Eighth street, west of Elm, and is making rapid preparations to go into the electric light business on a large scale. It is the only powerful company of which the Cincinnati Gaslight and Coke Company has thus far failed to obtain control. Ex-Gov. Foraker, who is the legal head of the Cincinnati Edison Company, declares that the company cannot be bought, that it means to be a rival of the gas company monopoly, and to furnish light and power to all the streets along which it is permitted to pass its lines. From all appearances there will no longer be a monopoly of lighting in Cincinnati. The company now has on file an application to open up several main streets near the vicinity of its plant. It was granted a franchise by the courts some time ago, and already has its wires laid on a number of thoroughfares.

SOUTHERN NOTES.

NORFOLK, Va., May 9, 1891.

The Selma (Ala.) Street Railway Company will change its lines to an electric system this summer.

Lynchburg, Va.—The Bertha Zinc Company is putting in an electric light plant at its zinc mines near the city.

Baltimore, Md.—Mr. J. H. Irwin is preparing to establish an electric light plant at Round Bay, near Baltimore.

Birmingham, Ala.—The Consolidated Electric Company, with $500,000 capital stock, has recently been incorporated.

Bristol, Tenn.—The Danville and East Tennessee Telegraph Company has been incorporated, with a capital stock of $90,000.

Louisville, Ky.—A fine six-story building, 224 × 60 feet in dimensions, has been completed by the Louisville Steam and Electric Motor Power Company, to be used as a power plant. The station is now being equipped with the latest improved machinery.

Graniteville, S. C.—The Cotton Sholes Electric Light and Power Company is being organized to establish an electric light and power plant.

Colorado City, Tex.—A contract has been awarded to the Delphon Electric Light Company, of Belton, Tex., for the erection of an electric light plant

Memphis, Tenn.—A contract has been awarded by the Citizens' Street Railway Company to the Edison company, of New York city, for an electric power plant.

Little Rock, Ark.—The capital stock of the City Electric Street Railway Company has been increased to $500,000. This road is to be changed to an electric system.

Burnt Mills, Md.—A movement is now being made for the construction of an electric railway to Brookville. Messrs. Water and Manaller are among those interested in the enterprise.

Houston, Tenn.—The Houston Rapid Transit Railway Company has been incorporated, with a capital stock of $300,000, to build an electric street railway. The incorporators are: J. T. Wilson, J. A. Patton, and H. J. Wilson. V. N. B.

ENGLISH NOTES.

LONDON, April 29, 1891.

Litigation in Connection with Transformer Substations.—An action brought by a Bond street firm against the London Electric Supply Corporation for the purpose of restraining them from erecting transformer substations in that neighborhood, owing to their alleged danger, came on for hearing last week, and has resulted in a decision which still leaves this important question open. The judge was apparently satisfied that the room in which Mr. Ferranti's transformers are actually placed was of a thoroughly fireproof character, but he also seemed to lean to the opinion that the whole of the building should be made fireproof, and he, therefore, adjourned the case for three months in order to see what extra precautions the company would take in order to render any fire which might break out on their premises harmless to surrounding buildings. Transformer substations have, therefore, so far escaped being judicially indicted as a "nuisance."

Agitation Amongst Telephone Subscribers.—On Wednesday last a public meeting was held with a view of forming an association of subscribers to the London exchange of the National Telephone Company for the purpose of securing reduced rates and an improved service. It does not require an association to convince the long-suffering Londoner that either the rates should go down or the service go up, or both, but united action is requisite to give effect to this widespread feeling; a powerful monopolist like the National Company is not likely to give way to mere agitation. The promoters of this association have bethought themselves of this fact and have succeeded in drawing an oracular pronouncement from the post-office. "As to any action which the post-office itself might be prepared to take," writes the Secretary to the post-office, "I am to say that the Postmaster-General could not be indifferent to a clearly expressed demand for the establishment of a telephonic service in London." The association therefore proposes first of all to endeavor to secure its objects by the pressure of united action, but should success not crown its efforts in this direction, the aid of the post-office is to be invoked, as that department is apparently ready to start a rival service in London, provided the public dissatisfaction is made sufficiently evident to it.

The Use of Condensing Engines in Central Station Work.—A very interesting discussion is in progress on Mr. Crompton's paper on "The Cost of Generation and Distribution of Electrical Energy" at the Institution of Civil Engineers, but up to the present by far the most important and valuable contribution has been from Mr. Willans, maker of the well-known Willans engines. He has carefully determined the consumption of water per hour with different loads upon the engine, and shows that this is directly proportional to the load + a constant. Interesting as this is, the method applied to the economy of condensing engines is of far greater importance, for it is found that for the same engine the increment for the consumption of water bears exactly the same relation to the horse power, but the constant is different. Plotting these carefully, the two slant lines are parallel, but cut the line of no horse-power at two different points. It is, therefore, very evident that, although on full load the saving by condensing may be small and may indeed be hardly worth effecting when the friction of air condensers or the cost of other condensing apparatus is taken into account, a very great economy is effected on lower loads. Since the electrical engineer is compelled to run the engines at practically uniform speeds, and cannot, as in hydraulic work, vary the speed with the output, hence the use of condensers on lightly loaded engines assume a new importance, which should be carefully considered by engineers of supply stations.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Motors in Lighting Circuits.—Is it a common practice to connect motors in incandescent lighting circuits? J. L. W.

Yes. Small fan motors and motors for driving sewing-machines, etc., are usually connected in the house lighting circuits. Large motors would be likely to cause too great fluctuations in the lights and should be connected rather cautiously.

Ampere Turns.—Will you please give me an explanation of "ampère turns" and the method of finding the ampère turns of a given field magnet? E. F. G.

The number of turns of wire upon the magnet multiplied by the number of ampères of current flowing in that wire gives the ampère turns.

Dynamo Design.—Seeing that you will give information on electrical subjects in your "Correspondents'" column, I wish to ask you for directions for the designing of a small dynamo which would run about two 16 c. p. incandescent lamps. F. E. K.

Our correspondent should have read the note at the head of this column, and should realize that we cannot enter into the work of designing electrical machinery. The various books and papers upon the subject should be carefully studied.

Horizontal Component of Earth's Magnetism in Iowa.—Will you inform me what is the horizontal component of the earth's magnetism in Central Iowa for 1891, and what allowance must be made for that of 1892? J. R. C.

The horizontal component of the earth's magnetism in Central Iowa is now about 4.3, but as no recent observations have been published we cannot say how exact those figures are. It is impossible to give formulæ for the precise variation at any particular place. The only accurate way of knowing is by personal observation. The figure given is in terms of the foot-grain-second system.

News of the Week.

THE TELEGRAPH.

Pennsylvania Lines.—Mr. David Hardy is arranging to commence at once the construction of the new line for the Pittsburgh Postal Telegraph Cable Company from Pittsburgh to Harrisburgg, Pa.

The Writing Telegraph.—A practical test of the writing telegraph for long-distance transmission was made between Pittsburgh and New York on Sunday, May 3, the wires employed being the new copper ones of the Postal Telegraph Company between the two cities. The result was fairly satisfactory. It was found that the machine must be placed on a very firm foundation, as the slightest jar prevents accurate working.

THE TELEPHONE.

Leesburg, Fla.—An ordinance has been passed granting a franchise to G. C. Stapylton, John Ellis, W. D. Taylor and others to operate a telephone system in Leesburg.

Pineville, Ky.—Mr. Andrew Johnson has been granted a permit to install a telephone system in Pineville.

Norway, Mich.—The work on the new telephone line between Iron Mountain and Norway, Mich., is progressing rapidly.

Mississippi Telephone Systems.—The towns of Okolona, Buena Vista and Houston will soon be connected by telephone. It is expected that the line will be completed in 30 days.

The Bell Telephone Company's new building at Hamilton, Ont., is to be ready for occupation early in July. It will contain a new multiple switchboard capable of accommodating 3,000 subscribers. It is said to be the intention to reduce the present rates to small consumers.

Deprived of Gum and Hello.—A telegram from Detroit says that the operators in the telephone exchange in that city are exceedingly angry over the new rules of the company, which prohibit the chewing of gum during working hours, interdict flirtatious conversation over the wires, and require them to say "number" instead of "hello."

THE ELECTRIC LIGHT.

Mineola, Tex., is soon to receive bids for an electric light plant.

Hackettstown, N. J., is to advertise for bids for a municipal incandescent electric light plant.

Newnan, Ga., is to establish an electric light plant in conjunction with its proposed water-works.

Rochester, N. Y.—The State Industrial School is to purchase an electric light plant. The cost is to be $15,000.

Watkins, N. Y.—The local electric light plant has purchased a new building and is to greatly increase the plant.

Medina, N. Y.—The electric light plant is now in successful operation, and a large number of subscribers are already secured.

The Ohio Valley Electric Light Company has been organized to furnish light for the suburban points along the Fort Wayne Railroad.

Iowa City, Ia.—The new apparatus for the increase to the plant of the Iowa City Electric Light and Power Company has been placed in position.

The Santa Rosa Lighting Company has broken ground for the immense improvements to be made at its plant. The company will spend about $30,000 in improvements this year.

Lockhaven, Pa.—The electric light company is to make many improvements in its plant this summer A dynamo of 2,000 lights capacity has been ordered and a new line of shafting is being installed.

The Carpenter Electric Light and Power Company, Catlettsburg, Ky., will put in an additional steam plant of 100 to 150 h. p. capacity at once, and may change the direct current incandescent system to the alternating.

Indianapolis, Ind.—The C. C. Perry Incandescent Electric Company has begun work on the extension of its conduit system, which is to be made to reach out into the residence districts of the city this summer. The conduit extends over three miles.

Venice, Ill.—The work of lighting the village has been commenced and the contracts for the required buildings, engines and material have been let. An additional dynamo will be placed in the plant for the purpose of supplying citizens with incandescent lamps in stores and residences as soon as required. The contract given out by the Village Board is for twelve arc lights at $1.25 per light. The plant will be completed within two months.

Troy, Ala.—The new electric light plant was formally opened last week with 40 lights in circuit. The plant belongs to the city, and is equipped with one 50-light Thomson-Houston arc dynamo and one 650-light alternator. The steam plant consists of one 100 h. p. Phœnix engine and a 125 h. p. Phœnix boiler. The station is supplied with a Wainwright feed water heater and Schieren belts. The lights were first turned on by Mrs. Henderson, the wife of the mayor of Troy.

Mr. C. A. Ross, the Kansas City manager of the Thomson-Houston Electric Company, has sold the following apparatus thus far this season: 30-light arc plant, Memphis, Mo.; 30-light arc plant, Norborne, Mo.; 30-light arc and 650-light incandescent, Olathe, Kan.; 25-light arc, Carrollton, Mo.; 50-light arc and 650-light incandescent, Clinton, Mo.; 35-light arc, Parsons, Kan.; 650 light incandescent, Maryville, Mo., and 50-light direct incandescent to the Smith Steam Baking Company, Kansas City, Mo.

THE ELECTRIC RAILWAY.

Rae Railway Motors in Use.—There are in use and contracted for 337 Rae electric railway motors upon 33 street railways in 29 cities. Others have been negotiated for, but contracts have not been signed. Those now in use range from 15 to 40 h. p., being mostly 30 h. p.

The Transcontinental Street Railway Company, of Portland, Ore., recently purchased by the Willamette Bridge Railway Company, has just closed a contract with the Thomson-Houston Company for 25 special street-car equipments. The cars will be double-truck pattern, made by the Pullman company.

The Sterling Trolley Hanger.—Mr. S. S. Crieder, of Sterling, Ill., to whom credit was given for the Sterling trolley hanger recently described in THE ELECTRICAL WORLD, calls our attention to the fact that Mr. Walter R. McCann deserves a part of the credit for the invention. These two gentlemen were the joint inventors of this piece of apparatus.

East Liverpool, O.—The city council has given the Thomson-Houston Electric Street Railway Company a franchise for constructing an electric street railway. When completed the road will be nine miles long, running from the east end of East Liverpool to the west end of Wellsville, O. The capital stock of the operating company is $150,000.

Mr. Paul W. Bossart, of the Short Electric Railway Company, of Cleveland, O., is making an active and efficient canvass in street railway circles of the West He reports the most favorable outlook for the new gearless motor. Every one is interested in it and speaks in the highest terms of its simplicity, predicting a successful future for this new departure of the Short company.

Atlanta, Ga.—The Industrial Improvement Company, an ally of the Thomson-Houston Electric Company, has secured control and consolidated the four street railways of Atlanta, Ga., having a combined mileage of 60 miles, and formerly capitalized for $700,000 stock and $1,050,000 bonds. The new company has been capitalized by the addition of $700,000 bonds, making $1,750,000 (the amount of the former stock and debt), and $2,000,000 stock, making the stock and debt $3,750,000, against $1,750,000 formerly, an increase of about 114 per cent. The additional bonds, $700,000, have been sold, and the proceeds will, it is said, be sufficient to change the motive power from animal to electricity. Two of the lines are already equipped with electrical appliances. The directors of the new company, the Atlanta Street Railway Company, are C. A. Coffin, of Boston; Frederick Ayer, of Lowell; Oliver Ames, A. A. Glasier and J. F. A. Clark, of Boston; John H. Watson, of New York; Joseph Hurt, A. E. Thornton, Henry A. Inman, R. J. Lowry and H. E. W. Palmer, of Atlanta. Mr. Hurt will be president.

GENERAL APPLICATIONS OF POWER.

Electric Power in Virginia City Ore Mills.—The dynamos on the Sutro Tunnel level, which furnished power for the Nevada mill at Virginia City, Nev., in conjunction with the Pelton water-wheel on the surface, are now running in full blast and the mill is being worked to its full capacity. The capacity of the mill is about 250 tons of ore a day.

Edison Mine Drills in Idaho.—Mr. O. B. Hardy, owner of the Black Bear mine, located in the Cœur d'Alenes, Idaho, has closed a deal with Mr. W. T. McCaskey, of the Edison company, for the construction of ten electric drills, which will take the place of compressed-air drills in his mine. The cost is $8 000. The plant is expected to be in operation this week.

LEGAL NOTES.

Brush vs. Cleveland Electric Light Company.—In the case of the Brush Electric Company versus The Cleveland Electric Light Company, which has been before Judge Ricks in the United States Circuit Court, the Brush company, the complainant, has dismissed the case without prejudice.

The French Cable Company.—An important decision was given recently in Paris in the case against the French Cable Company, which has been pending for several years, and in which the contention has been that the company could not, under its agreement, withdraw from the pool of the Atlantic cable companies. The claim of the French company has been that the letter of the Minister of Dec. 30, 1886, raising the point of its right under the concession to enter the pool, was a peremptory order for it to withdraw from the pool, and it was so decided by the Council of the Prefecture in March, 1889. This decision was appealed from to the Council of State, which now reverses it.

Electric Riveting Interference Decision.—An important decision has been rendered by the Examiner of Interferences in the United States Patent Office, in which priority of invention of the art of electric riveting and also of the apparatus for practicing this art was awarded to Mr. Elias E. Ries, of Baltimore, the other party to the interference being Prof. Elihu Thomson, of Lynn, Mass The interferences just decided were two in number, the first being between the patent of Elihu Thomson, No. 396,015, dated Jan. 8, 1889, for a method of electric riveting, and an application of Elias E. Ries that was pending in the Patent Office at the time this patent was granted. The second interference was between a patent to Elias E. Ries, No. 403,374, granted May 14, 1889, and an application of Elihu Thomson, filed June 14, 1889, for apparatus for electric riveting.

Great Western Telegraph Company's Case.—Master in Chancery Boyerson filed his report in Chicago last week in the celebrated case of ex-United States Senator Charles B. Farwell against the Great Western Telegraph Company and others to set aside the claims of Selah Reeve, the Commercial National Bank, George F. Harding and John Clark Hilton, and to vacate an assessment of 35 per cent. against 1,200 stockholders of the company to meet an alleged indebtedness of $350,000. This assessment, it was charged, was void because of the frauduient claims allowed against the estate. The master recommends that the decree of assessment be set aside, which relieves the stockholders; that the claims of Selah Reeve and Thomas J. Sutherland against the estate be expunged as invalid; that George F. Harding be compelled to account for some $60,000 alleged to have been received by him in excess of the amount of his claims; that Sutherland be obliged to account for the claims held by him against the company, and that a personal decree be entered against Sutherland, Harding and Franklin D. Gray for the amount received by them from the sale of the lines of the company. The Master finds that the decree of assessment was procured by fraud and collusion, and therefore cannot stand.

PERSONALS.

Mr. Wm. Hull, superintendent of the Albany, N. Y., fire alarm telegraph office, died May 9, of pneumonia.

Mr. J. P. Barrett, the chief of the electrical department of the World's Fair, was in New York last week on business connected with the Exposition, and was a caller at our office. He hopes to have all matters connected with the electrical exhibit properly adjusted at an early date.

Mr. S. D. Greene, well known to electricians through his successful work in connection with the Sprague and Edison companies has accepted the position of consulting electrician of the Burton Electric Company. Mr. Greene has for a number of years taken a great interest in the heating of street cars by electricity, and in the winter of 1888 made some tests of the Burton heater, reporting favorably upon its economy.

Mr. William W. Jacques, the electrician of the American Bell Telephone Company, who has been travelling in Italy with his family, was savagely attacked last week in Florence by a mob of Italians. He was riding in a carriage with his daughter, and was pursued by the crowd, which pelted the couple with stones, severely injuring his daughter. The assault was unprovoked.

MISCELLANEOUS NOTES.

Washburn & Moen, of Worcester, Mass., after many experiments, have, it is said, discovered a process by which copper wire can be made that will stand a strain and tension equal to steel wire.

Storage Batteries in Canada.—An Ottawa (Can.) syndicate is seeking incorporation under the name of the "Anglo-Canadian Electric Storage and Supply Company," for the purpose of manufacturing, selling and leasing secondary batteries, and all kinds of electric supplies and appliances.

A Correction.—Our attention has been called to an error in Mr. Colgate's article on "The Construction and Care of Electric Railroads" in THE ELECTRICAL WORLD of March 21. In the second paragraph on page 224 the statement is made that the conductivity of silicon bronze trolley wire is from 25 to 40 per cent. higher than that of copper. The word "conductivity" should, of course, have been "resistance."

Industrial and Trade Notes.

The Illinois Electric Material Company, of Chicago, is now Western sales agent for the Giles poles, mast-arms, brackets, etc.

Mr. M. C. Chase, of Canal street, Chicago, Ill., is manufacturing some handsome specialties in hard rubber for the electrical trade.

The Globe Light and Heat Company, of Chicago, Ill., has removed from Michigan street to Lake street. Mr. E. R. Crolins remains in charge of the electrical department.

The Scott Electrical Manufacturing Company, whose electro-calcium light was recently described in the columns of THE ELECTRICAL WORLD, has six of these lights now in use at the Casino, in this city, where they are giving excellent satisfaction.

The Gibson Electric Company, 74 Cortlandt street, has removed its office from Room 411 to Room 402 in the same building, and by the change better accommodations have been secured. Mr. Gibson is very well satisfied at the way his indestructible battery is selling.

The Ball Engine Company has issued a pamphlet containing copies of a large number of commendatory letters received. The Ball engine is used in so many successful electric light plants, in the country that hardly any letters can better show the excellence of these engines than the tests of lighting stations.

Messrs. J. Lang & Co., of Michigan street, Chicago, Ill., are bringing out a new incandescent switch of the "Andrews" type, having an air space of four inches between contact points. Of the large form of "Andrews" switch they have shipped 377 thus far this year, which speaks well for their popularity and efficiency.

Rewinding of Armatures.—In addition to the manufacture of dynamos and motors, the Ford and Washburn Electric Company, of Frankfort street, Cleveland, O., is equipped with a full complement of experienced men and the necessary machinery to rewind or repair armatures of any type, and to replace worn commutators on short notice.

The Reliance Gauge Company, East Prospect street, Cleveland, Ohio, has several of its electrical alarms in use, and all are giving good satisfaction. The electrical alarm placed by this company in the Studebaker works in South Bend, Ind., is adjustable from one inch to 36 inches, thus allowing of a variation of three feet between high and low water.

The National Carbon Company, of Cleveland, O., is not only turning out a greater number of electric light carbons than ever before, but carbons of a higher quality, due to perfected processes resulting from continued and costly experiments. This company has just issued a new price list of its perfected dynamo and motor carbon brushes having true parallel sides.

The William M. Wilkinson Patent Oil Cups and Oil Feeders are being used more extensively every month, and the fact of their use by such companies as the Thomson-Houston, McIntosh & Seymour and Ball Engine companies, and many others of that class, certainly speaks well for their efficiency. During a period of over 20 years of actual service not one of these oilers has been returned to the manufacturers.

The American Fuel Economizer Company, manufacturer of improved economizers under the patents of Geo. H. Burpee, has opened offices at 136 Liberty street, in the new Electrical Exchange building. These economizers have evidently jumped at once into popular favor, as they have been adopted by the new stations at New Haven (electric light) and Buffalo (street railway). The Narragansett Electric Light Company, of Providence, is also using three of them.

The Short Company's New Motor.—The gearless motor of the Short company is meeting with universal commendation. Already the first factory order is pledged, and the company is closing large orders, which will tax the capacity of the shops for a long time to come. The first gearless motor has now fairly entered on its eleventh week of service with a remarkable record. Although subjected to the severest tests, there has been no trouble from beginning to end. The first motors of the first factory order are beginning to come out and will be placed in regular service this week, when the Short company proposes to demonstrate its ability to make an absolutely successful gearless motor.

The Ball Engine Company, of Erie, Pa., has published a most useful pamphlet, giving a list of electric light and power plants using the Ball engines throughout the United States. The names are arranged under the heads of the various systems in vogue in the country, and altogether the list is the best we have seen. Following is a list of the systems named in the pamphlet: American, Ball, Bernstein, Brush, Continental, Edison, Eickemeyer, Excelsior, Fort Wayne Jenney, Fuller-Wood, Heisler, Indianapolis Jenney, Loomis, Mather, Mayo, Queen City, Sawyer-Man, Schuyler, Silvey, Sperry, Thomson-Houston, United States, Universal, Van Depoele, Westinghouse and Western Electric. A list of electric railway plants is also given.

Rawhide Gears.—The New Process Rawhide Company, of Syracuse, N. Y., has received from Mr. Wm. M. Ramsey the following testimonial as to the durability of these gears in use on the Federal street and Pleasant Valley Railway, at Allegheny, Pa.: "I write to let you know of our continued success with your rawhide pinions. We have had them put to the most severe tests on 12½ per cent. grades and find that they stand the work admirably. They will outwear steel and iron pinions, and are superior to bronze in many respects. Can especially commend your new 'flanged' pinion to roads having long or steep grades. We have tried *every* make of pinion known, metal and otherwise, and can say without any qualification that 'new process rawhide' has no superior."

The Franklin Electric Company, of Kansas City, Mo., has recently been established for the purpose of carrying on construction, supply and repair works in the States of Missouri, Kansas, Arkansas and Texas. Mr. Geo. E. Claflin, of the Franklin Company, was formerly connected with the Waterhouse Company, and for the last two years has been the district engineer at St. Louis for the Westinghouse Electric and Manufacturing Company. Mr. A. M. Miller, who is a practical mechanical engineer, has been associated with Mr. Claflin in construction work in this section for some time past. W. H. Blood, Jr., was for two years connected with the Thomson-Houston Electric Company in the factory at Lynn, Mass., as foreman of the assembling room. All three of the above partners are practical engineers, Messrs. Claflin and Blood being graduates of the Massachusetts Institute of Technology.

Cornell University Souvenir.—Mr. Frank C. Perkins, one of the Cornell students and an associate member of the American Institute of Electrical Engineers, has just issued a very creditable publication entitled, "Cornell University: Her General and Technical Courses." The book contains something over 100 pages, and its scope is well defined by the title. About one-half of the pages are taken up with full-page illustrations of the exterior and interior of the various university buildings, each one accompanied by a portrait of the professor most intimately connected with that particular department. The illustrations are very clear and very complete. Those of the greatest interest to the electrical fraternity are the physical laboratory, in charge of Prof. Nichols; the electrical laboratory, in charge of Prof. Moler; the dynamo-room of the university lighting plant, in charge of Prof. Ryan, and Sibley College laboratories, which are under the immediate direction of Prof. R. H. Thurston.

The Ball & Wood Company.—Mr. Frank H. Ball has issued the following announcement: "Having terminated my connection with the Ball Engine Company, of Erie, Pa., I have sold all my recent patents and inventions covering engine-governing devices to the Ball & Wood Company, No. 15 Cortlandt street, New York city, a corporation possessed of ample capital, which I have organized, with others, for the purpose of building improved Ball automatic cut-off engines. Our new company has purchased of the Central Railroad Company of New Jersey a very desirable site of four and a half acres adjoining its tracks at Elizabethport, and 20 minutes from our New York office. We are erecting machine shops on the approved gallery plan, and equipping them with new and modern tools, solely with a view of building our specialty, improved Ball engines, with the greatest economy and excellence. Associated with me are gentlemen who have spent their lives in the engine business, and with the experience of 20 years myself, devoted exclusively to engine work and covering the introduction and development of high-speed automatic cut-off engines, I confidently believe that the new Ball engines I am designing will not only maintain, but decidedly eclipse, the excellent reputation acquired by those heretofore built by me in Erie, where the disadvantages of inferior facilities necessarily hampered us in attaining the perfection we sought." Mr. Wood assumes the presidency of the new company; Mr. Vincent, of Chas. R. Vincent & Co., will become its secretary and treasurer, and to Mr. Smith will be intrusted the interests of the company, with his principal office at Cincinnati, his old home.

Business Notice.

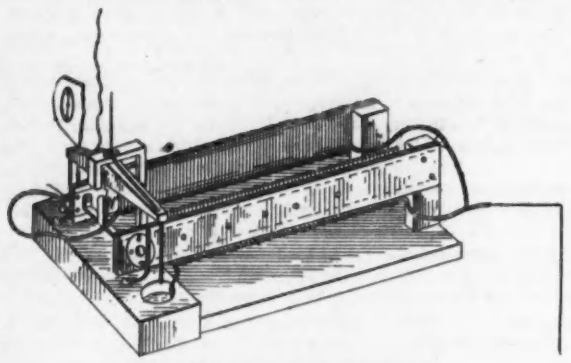
Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MAY 5, 1891.

451,445. Secondary Battery; Truman H. Aldrich, of Cincinnati, O. Application filed Dec. 27, 1890. In an electrode for secondary batteries, a body of active material formed with an aperture adapted to receive a conducting plate and a conducting plate taking loosely into the same.

451,449. Telegraph Repeater; Albert C. Booth, of Cedar Rapids, Ia., Assignor of one half to William P. Ward, of same place. Application filed April 24, 1889. The invention comprises two relay magnets, two fixed electrodes, two spring keys, co-acting respectively with said electrodes at a repeating station, and two normally closed electric circuits extending to two distant stations, one of said relay magnets, electrodes and spring keys being located in each of said circuits, in combination with metallic pivoted levers, respectively carrying the armatures of the said respective relay magnets, electrodes co-acting with said levers, but



No. 451,520.—ELECTRIC METER.

normally out of contact therewith, a repeater battery, wires connecting one pole of said battery with said levers, repeater magnets connected by wires with the said electrodes, both of said magnets being also connected with the opposite pile of said battery, a balanced swinging lever carrying on opposite ends the armatures of said magnets, and a crank arm carried by said lever and located in co-operative relation between both of said spring keys.

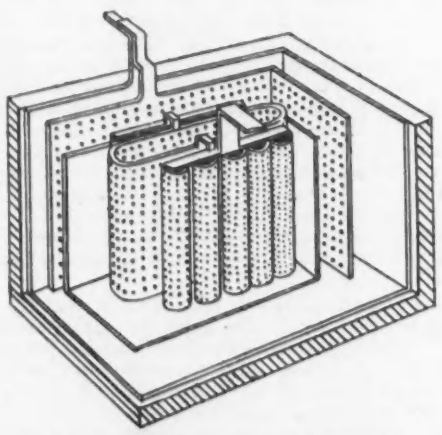
451,491. Electric-Railway Truck; Walter H. Knight, of Boston, Mass. Application filed Feb. 15, 1890. This invention consists in providing each of the two axles of an electric-railway truck with a propelling motor, the two motors having extensions therefrom projecting inwardly and flexibly connected together, so that the two axles have freedom of radial adjustment for facilitating the action of the truck upon a curved track.

451,512. Multiple-Signal Transmitter; Bernice J. Noyes, of Boston, Mass. Application filed Sept. 22, 1890. In a multiple-signal transmitter, a train and a let-off, combined with a removable signal wheel and means controlled by the signal wheel for moving the let-off.

451,514. Electric Brake; Joseph Mitchell Payne, of Cressona, Pa. Application filed March 31, 1890. The combination of a brake apparatus having armatures, electromagnets to attract the armatures, a battery, circuit closer, conductors connecting the battery and the electromagnets, and electrodes attached to the said conductors and supplied in perforated lugs extending laterally from the drawbars of the car, said electrodes having spring-clamps to connect them together between the cars.

451,520. Electric Meter; Edwin Wilbur Rice, Jr., of Lynn, Mass. Application filed March 8, 1889. An electric meter having a controlling or actuating mechanism consisting of an expansible rod or bar heated when expanded by the influence of an electric current and a compensating rod or bar attached to the same, but separately mounted or supported, so as not to be heated by conduction or radiation therefrom and adapted to act in opposition to the first, when both are heated at the same time. (See illustration.)

451,521. Combined Switch and Lightning Arrester; Edwin Wilbur Rice, Jr., of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed March 5, 1890. The combination, with a manual circuit-



No. 451,541.—SECONDARY BATTERY.

breaking switch in an electric circuit, of a blow-out magnet having poles adjacent to the contact point of the switch, and a supplementary lightning arresting contact also adjacent to said poles and connected to the ground.

451,540. Secondary Battery; George A. Washburn, of Cleveland, O., Assignor to Ford & Washburn, of same place. Application filed July 23, 1890. In a storage battery, an insulating casing for the cell, having a cup lining of conducting material, an inner wall of conducting material apart from said lining, and active material between said wall and lining, in combination with a battery element centrally within said case.

451,541. Secondary Battery; George A. Washburn, of Cleveland, O., Assignor to Ford & Washburn, of same place. Application filed Oct. 24, 1890. In a storage battery cell, a porous pot containing active material and conductors in the pot constructed to form an open space in the pot for solution and to yield under lateral pressure or expansion. (See illustration.)

451,548. Temperature Alarm; Louis Zagelmeyer, of West Bay City, Mich. Application filed Dec. 8, 1890. In a thermometric electrical instrument, the combination, with the base, of a thermostatic coil loosely sleeved upon a standard and having one end secured thereto, a radial arm formed on the other end of said coil, two index hands frictionally secured on a pivot in the axis of the coil, and thermometric scale for adjusting the index hands and the arm of the coil. (See illustration.)

451,559. Electric Motor; Walter E. Hyer, of Newburg, N. Y. Application filed Nov. 26, 1890. In an electric motor, the combination with an armature of a field magnet having a single coil surrounding the armature and standing in a plane oblique to its shaft, the magnetic circuit being composed of two hollow castings bolted together on a plane including the armature shaft, said castings containing each one-half of the journal boxes of the armature shaft.

451,574. Dynamo-Electric Machine; Lewis C. Rice, of Denver, Colo. Application filed May 14, 1890. A field magnet structure, composed of bobbins having grooves in their adjoining sides, and bolts passing through the holes formed by said grooves; also an armature made up of a series of sections longitudinally grooved upon their outer surface and suitably joined together, the upper portion of each section being cut away for the insertion of the coil, and the sections when joined together inclosing the coils at the point of contact. (See illustration.)

451,586. Insulated Electric Conductor; James B. Williams, of Oakland, Cal. Application filed July 12, 1890. In an insulated electric conductor, the combination with the conductor and its surrounding dielectric of a centering device composed of fibrous material saturated with an insulating material not so readily softened by heat as the material of the dielectric.

451,587. Insulated Electric Conductor; James B. Williams, of Oakland, Cal. Application filed Nov. 13, 1890. An insulated electric conductor consisting of a central metallic conductor, solid, stranded or tubular, and substantially circular in cross-section, surrounded by a dielectric which is itself usually surrounded by one or more waterproof protecting coverings.

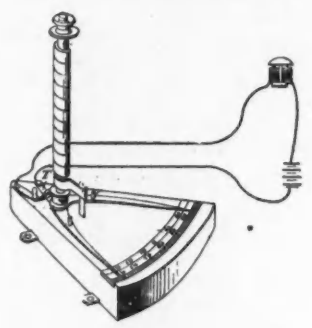
451,603. Magnetic Attachment for Windows; Thomas N. Sterry, of Norwich, Conn. Application filed July 2, 1890. A window and sash, one bearing a magnet and the other a keeper.

451,605. Electric Conductor; Joseph D. F. Andrews, of Westminster, England. Application filed Oct. 31, 1890. The combination of the jointed ends of the core wires, their insulation and armor, the wires wrapped around the separated portions of the armor, the insulating envelope, the conducting sheath connecting the separated ends of the armor, and the metal cast around the whole in a mold.

451,614. Underground Electric Wire Conduit; Henry B. Cobb, of Wilmington, Del. Application filed April 29, 1890. In an underground conduit system, the combination of a conduit, conductors in the conduit, and supports spacing the conductor, and having the conductors secured to them independently of the conduit environment, the said supports being provided at intervals along the conductors, and being movably supported in the conduit.

451,634. Telephone Receiver; William S. Corwin, of Newark, N. J. Application filed Nov. 30, 1888. A telephone receiver combining therein a permanently magnetized steel casing or tube, a soft iron core or centre rod insulated therefrom at its rear end, a diaphragm, a bobbin of wire arranged on the core near the diaphragm, and conducting wires and connections.

451,637. Electric Railway System; Charles K. Harding, of Atlantic, Iowa. Application filed Oct. 27, 1890. In an electric railway system, the combination of an insulated main conductor, a series of stationary main-conductor contacts or electrodes pro-



No. 451,548.—TEMPERATURE ALARM.

tected in insulated cups, electrically propelled vehicles having current collectors carried thereunder, and a movable circuit completing device normally insulated from the main supply conductor, but adapted to contact with the main conductor.

451,639. Alarm Signal; Michael A. O'Donnell, of Chicago, Ill. Application filed March 17, 1890. In an alarm signal, the combination of a club or baton having a signal inserted in its handle, and a signal operating shaft of a patrol box operated by the mouth of said signal.

451,649. Electric Stop Motion; Chas. A. Dayton, of Preston, Conn. Application filed April 21, 1890. In an engine, in combination with the driving-shaft of the governor, a clutch pulley on said shaft, a system of levers connected with said pulley, as set forth, and an electromagnet whose armature serves as a latch to control said levers to hold the two sections of the said clutch pulley in operative engagement.

451,656. Socket for Incandescent Lamps; Samuel Deacon, of Lynn, Mass., and Merle J. Wightman, of Hartford, Conn., Assignors to the Thomson-Houston Electric Co., of Connecticut. Application filed March 15, 1890. A lamp socket switch consisting of a rectangular block, a spindle for turning the same loosely connected thereto, the said block connecting at one side with one terminal of the circuit and on the opposite side with a spring connected to the opposite terminal and having freedom to adjust itself between the two terminals.

451,689. Signal Box; Milton G. Davis, of West Somerville, Mass., Assignor by mesne assignments to the Municipal Signal Company, of Portland, Me. Application filed June 18, 1890. In a signal box, a signal transmitter, a winding arm, and a pull-down rod having teeth, combined with a pawl adapted to engage the said teeth and to be engaged by the winding arm when the latter is depressed to disengage it from the aforesaid teeth.

451,691. Mechanism for Carrying Trolley Wheels Underground; Joseph Holland, of Watertown, N. Y. Application filed Dec. 22, 1890. The combination, with the conduit body and the side trackway shelves therein, of transverse supports between said shelves, insulating blocks mounted upon said supports, and an electric wire carried by said insulating blocks.

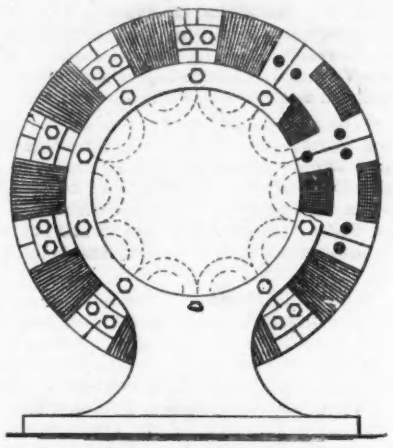
451,692. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor by mesne assignments to the Thomson-Houston Electric Company, of Boston, Mass. Application filed April 28, 1888. A railway track, a main line conductor extending along said track, a branch track, a branch conductor extending along said branch track, an electrical connection between the main line and branch conductors, and a switch between the main line and branch conductor and electrically connected with them.

451,696. Switch for Overhead Electric Conductors; John Kuehle, of Detroit, Mich., Assignor of one-fourth to Edward Martyn, of same place. Application filed Dec. 18, 1890. In a switch for overhead trolley wires, the combination, with three conductors adapted to be connected, respectively, with the main and switch wires and having their inner ends separated for the passage of the flanges of the trolley, of a flanged metallic cover to which the separated ends of the conductor are connected, forming an electric bridge for the flanges of the trolley.

451,700. Dynamo-Electric Machine; Lawrence N. P. Poland, of Cincinnati, O. Application filed May 7, 1888. The combination of the armature shaft, a longitudinally grooved cylinder, thin iron discs mounted upon said cylinder, insulating collars and clamping collars to hold the parts together.

451,732. Electric Car-Lighting Apparatus; Budd J. Jones, of Chicago, Ill. Application filed Oct. 17, 1890. In an apparatus for lighting cars, the combination, with the main lighting conductors, embracing the car lamps in series in the electric circuit, of a supplementary conductor, the headlight socket piece having contact plates, and the headlight having a plug adapted to enter said socket.

451,786. Method of Operating Reciprocating Electric Engines; Chas. J. Van Depoele, of Lynn, Mass. Application filed Jan. 3, 1891. This invention consists of an electric engine having one set of coils adapted to be energized by an intermittent



No. 451,574.—DYNAMO-ELECTRIC MACHINE.

continuous current and another set energized by alternating currents having a defined rise and fall.

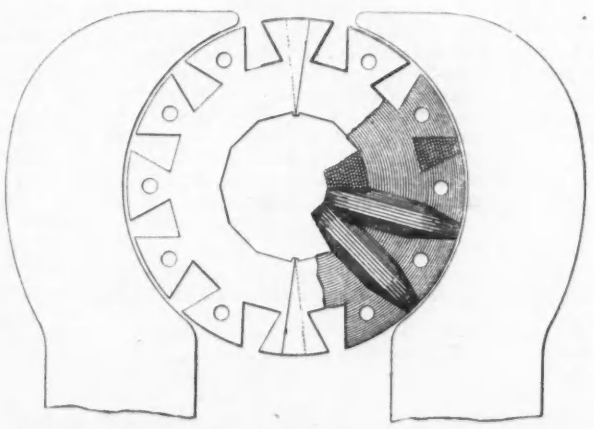
451,798. Current Regulator for Electric Lamps; Chas. H. Balsley, Jr., and Edwin M. Porter, of Connellsville, Pa. Application filed Jan. 17, 1891. The invention consists of a socket containing a variable resistance whereby the light may be increased or diminished.

451,815. Conduit System for Electric Railways; William H. Ford, of St. Louis, Mo. Application filed Oct. 8, 1890. A conduit electric railway having a bare conductor made up of sections of a predeterminate length, two mechanical contact devices, such as trolley arms, fixed upon a vehicle at a greater distance apart than the length of a single section of said bare conductor, and one of said mechanical contact devices having electrical wires mounted thereon and carrying connections for taking current from the sections of said bare conductor.

451,870. Electric Motor; Ernest M. Gardner Hewett, of Boston, Mass., Assignor to Albert L. Jewell, of same place. Application filed Nov. 14, 1890. An electric motor comprising a series of electromagnets, an armature composed of bars of soft iron, and a commutator consisting of a number of segments arranged in sets, each set containing a number of segments corresponding to that of the electromagnets, a series of plates placed within the segments, and of a number corresponding to the number of electromagnets, and provided with projections, each of which engages one of the segments of each set, a brush having a bearing surface less than the width of each interval between segments, and suitable electrical connections whereby each electromagnet is energized by the entire current only several times during each revolution of the armature.

451,872. Electric Motor; Frank M. La Boiteaux, of Cincinnati, O., Assignor of one-half to Henry Varwig, of same place. Application filed June 4, 1890. In an electric motor, the combination of the stationary base, the pivoted cap mounted thereon, the motor eccentrically mounted upon the pivoted cap, and insulated contact pieces to maintain the circuit between the main and motor wires, while the motor revolves upon its base.

451,884. Electric Motor or Dynamo-Electric Machine; Schuyler S. Wheeler, of New York, Assignor to the Crocker-Wheeler Electric Motor Company, of same place. Application filed April 23, 1890. The ring armature core formed with trapezoidal slots or openings in its periphery and coils of windings laid in the slots and passing through the inside of the



No. 451,884.—ELECTRIC MOTOR OR DYNAMO-ELECTRIC MACHINE.

ring, the windings on the inside of the ring forming trapezoidal-shaped coils or sections which fit against one another and fill the interior of the ring, and the slots being of the same shape and cross section, so that the coils are symmetrical with respect to the outside and inside of the ring. (See illustration.)

451,894. Electric Motor or Dynamo-Electric Machine; Wm. F. Collins, of Chicago, Ill., Assignor by mesne assignments, to the Crocker-Wheeler Motor Co., of New York. Application filed April 17, 1888. An armature core for an electric motor or dynamo-electric machine formed with trapezoidal slots in its periphery of greater width at the bottom than at the top, the windings or conductors being contained in the slots.

451,902. Fire-Alarm Telegraph Apparatus; Jos. W. Stover, of Newtonville, Mass. Application filed Jan. 23, 1888. The combination of a signal-box motor and a detent controlling the operation thereof with an actuating electromagnet for said detent, a local circuit therefor, an electromagnet in the main circuit of the box, and an armature therefor that controls the operation of said detent.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y